ANATOMICAL PLATES

OF

THE BONES AND LIGAMENTS

EDITED BY JONES QUAIN, M.D.
AND W. J. E. WILSON.

Dup. M.L.

Thomas John Eames Brown

Lt Thomas's Hospital

October 1st 1848

QUAIN and WILSON

[Anatomical plates Div. V.]

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THE

BONES AND LIGAMENTS

OF

THE HUMAN BODY;

IN

A SERIES OF PLATES,

WITH REFERENCES AND PHYSIOLOGICAL COMMENTS.

EDITED BY JONES QUAIN, M.D.

AND

ERASMUS WILSON.

LONDON:

PRINTED FOR TAYLOR AND WALTON,

BOOKSELLERS AND PUBLISHERS TO UNIVERSITY COLLEGE,

UPPER GOWER-STREET.

1842.

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PRINTED BY SAMUEL BENTLEY,
BANGOR HOUSE, SHOE LANE.

ADVERTISEMENT.

This Publication consists of a Series of the most approved Anatomical Drawings, some original, others selected from monograph treatises or from systematic works. The highest place in the monograph treatises is deservedly conceded to the works of Scarpa and Tiedemann, and, in the systematic works, to those of Mascagni and Caldani; but, from their size and the style in which they are executed, the expense of publication is necessarily such as to confine their usefulness to comparatively few persons. It may, however, be fairly admitted, that the collections of Cloquet and Loder, though not of equal pretension, are no less valuable to students, as a guide to the knowledge of that complex fabric whose composition they seek to investigate; and to those of maturer age, as a means of reviving impressions received during their earlier studies. As, however, even the works last named are to some inaccessible from their price, and to others from the descriptions and references being given in a foreign language, the want of a similar publication in an English garb has been for some time complained of.

To supply the want here noticed, and at a moderate price, is the object of the present undertaking. The Plates are accompanied by letter-press, containing detailed references to the various objects delineated, the names being set down in English, Latin, and French. But with a view to render them intelligible to a greater number of persons, a running comment on each Plate is given, stating, in general terms, the uses and purposes which the different objects serve in the animal economy. The Drawings are taken on stone by Mr. W. Fairland, from Drawings by Mr. J. Walsh and Mr. W. Bagg, and the printing executed by Hullmandel, Graf, and Fairlands.

The Work consists of Five Divisions, as follows:

First.—The Muscles.

Second.—The Heart and Blood Vessels (Arteries and Veins,) with the Lymphatic and Lacteal Vessels.

Third.—The Brain and Spinal Marrow; the Nerves and Organs of Sense.

Fourth.—The Organs of Digestion, Respiration, and Secretion.

Fifth.—The Bones and Ligaments.

London, Taylor & Walton, Upper Gower St.

Wm Fairland litho.

OSSEOUS SYSTEM.

The Osseous System (système osseux, ossa, *οστεα*) is peculiarly fitted, by its solidity and hardness, not only to give support to the soft parts, but also to furnish points of attachment to the muscles, by which the different movements are executed. This solid frame-work of the body is made up of a number of separate pieces, the aggregate of which has been termed "*the skeleton.*" It is a favourite opinion with some persons, that bones determine the form of parts, as well as the direction of the body. But we find, that in their developement they just keep pace with that of the soft parts, particularly of the central nervous masses. If these proceed regularly to their completion, so will the arches of the vertebræ, and the bones of the head; but, if their growth be retarded or deranged, the bones will not arch inwards, and so the spinal and cranial cavities will remain open. Again, if we descend through the series of animals, the skeleton becomes gradually more simple and rudimentary, until it is reduced to its fundamental part—the spine; and even this may be composed of cartilage, with scarcely a trace of calcareous matter. A few grades lower down in the scale, we find multitudes of animals altogether destitute of a skeleton, either internal or external, so that the muscular structure alone remains as the means of locomotion. Bone is, then, the passive instrument—muscle the active agent: muscle is, moreover, prior in its appearance and importance in the animal series, bone being secondary in both respects. It may be asked, are we still to persist in drawing such a broad line of distinction as has been hitherto done, between the hard calcareous parts of crustacea and insects, and the osseous system of higher animals, as that the latter alone should be considered to merit the name of skeleton, whilst the former is treated as a mere shell, or outward tegument? To put the question in a different way, is it more conformable with what we know of the economy of nature—is it more philosophic, to admit, at once and without examination, that these so-called shells or crusts are altogether new organs given to the animals they invest, (and as such destitute of any analogy with the structures observed in higher grades of beings, and with which we are in general more familiar,) or to scrutinize these different parts attentively, and carefully note the points of similitude, if any, which may exist between them, with a view to determine whether they are not really modifications, or repetitions, of what occurs in other tribes, and so trace out (what analogy goes a great way to establish) a unity of plan throughout the animal series? The researches of Geoffroy Saint-Hilaire and others have thrown much light on this important question. The mere position of parts, whether internal or external, is a matter of little moment: a consideration of their structure, and adaptation to purpose and use, can alone determine whether any correspondence exists between them. The internal skeleton of a vertebrate animal, and the external one of the articulata, appear to be really analogous parts in the economy of these classes of animals, notwithstanding the vast distance which separates them in the scale of being; and the difference, though confessedly a considerable one, which exists between the rachis of a crustaceous animal and that of a fish, reptile, bird, or quadruped, seems to arise from the circumstance that a spinal marrow exists in the one, but not in the other, a special conformation of the osseous system being required in each case.

PLATE I.

Skeleton of an adult male, anterior aspect. This figure is copied from Cheselden's beautiful plate. In his description of the figure, Cheselden observes that it is "in the same proportions and attitude with the Belvidere Apollo."

Situation.—The osseous structure is situated deeply, being covered by the soft parts and common integuments; at least, this is the case in the vertebrate animals.

The *number* of bones is differently stated by writers, the difference arising from the period of life at which the enumeration is made: in early age the number is greatest, and subsequently diminishes, when, by the process of ossification, two or more previously distinct pieces become united into one. Their *form* and *size* present a considerable degree of variety. They are usually divided into long, short, flat, and mixed.

The *long* or *cylindrical* bones belong in general to the parts intended for locomotion, and represent so many levers, to be moved by the muscles in various directions. When examined from the superior part to the inferior, viz. from the humerus or femur, to the phalanges of the fingers or toes, they are found to increase successively in number as they diminish in size—a disposition which gives to the superior division of each limb the great extent of motion it enjoys, whilst it allows to the inferior and terminal ones a variety of rapid movements within restricted limits.

Each long bone presents a body, or middle part, and two extremities. The shaft or body is round and cylindrical in some, prismatic in others, but somewhat bent or twisted on its axis, so that the direction of its superior extremity does not exactly correspond with that of the inferior. Whatever difference of outward form may obtain, there is little or none in that of the internal canal; it is circular in the tibia as well as in the femur. This canal is not intended merely to lodge and protect the medulla; it contributes very much to increase the strength of the bone, as has been satisfactorily shown by direct experiment. If two cylinders contain the same quantity of matter, one being solid, the other hollow, the power of resistance of the latter is greater than that of the former, owing to its greater diameter. By this conformation, also, bones, without being increased in weight, acquire an adequate degree of lightness, together with sufficient superficial extent to afford a more expanded surface for the attachment of muscles, which are important requisites in what may be considered as the passive organs of locomotion.

The *short* bones are usually situated in parts in which solidity and firmness are required to be combined with freedom of motion; for instance, in the carpus, tarsus, and vertebral column. Their external conformation is necessarily influenced and determined by that of the parts into whose composition they enter; and as they are intended to co-operate in certain common functions, they present a number of articulating surfaces, prominences, and depressions, suited to their mode of adaptation and mutual connexion.

The *flat* or *broad* bones for the most part serve to form the walls of cavities, or to enclose spaces. They present two surfaces, one convex, and the other concave; which conformation, by giving them an arched form, increases their power of resistance, and affords additional security to the organs they enclose. The bones of the skull and pelvis come under this denomination.

Some are so irregular in their form as not to be referrible to either of these heads. These are situated along the median line, as the occipital, the sphenoid, and ethmoid bones, and the vertebræ.

In addition to these divisions into classes, adopted by all writers, those who treat expressly of descriptive anatomy are obliged to have recourse to others. Thus, in order to facilitate the description of irregular bones, such as the ethmoid, or the sphenoid, they are considered as being divisible into a central part or body, and processes; the anatomical situation of the parts forming the ground of division. In other instances it is supplied by the mode of developement, as of the os innominatum into ilium, ischium, and os pubis. Finally, in some, the division is founded on the situation and relations of their parts, as when the frontal bone is resolved into a frontal, nasal, and orbital portions.

The *surfaces* of bones are marked by eminences and depressions adapted to various purposes. The eminences may be ranged under four heads. 1st, those of articulation; 2nd, insertion; 3rd, impression; 4th, reflection. Those for articulation vary according as they are movable or immovable, and shall be described in the next chapter. Those for insertion are variously adapted for the attachment of muscles, or for tendons and ligaments. They present numerous differences in their degree of projection, according to the sex, age, and muscular developement of each individual. Their form is equally various; some consisting of diffused asperities, others extending along the surface like rough lines, whilst others project more or less from the bone, and are intended not only to give insertion to muscles, but also to serve the purpose of increasing their power of action, by removing their line of direction farther from the axis of the bone.

The eminences of impression are certain prominent lines interposed between depressions on the surfaces of bones. Thus, the shallow pits on the cranial bones corresponding with the convolutions of the brain, and the depressions on the external surface, marking the insertion of muscles, are sepa-

rated by prominent lines, termed eminences of impression. The expression appears not to have been well chosen; it was originally founded on the supposition that the action of contiguous organs, by depressing certain parts of the surface of the bone, served to elevate others; but it is far more conformable to what occurs in other structures, to refer to the laws of nutrition and growth (by which different parts are mutually adapted to one another) the inequalities here alluded to, as well as those more prominent points to which muscles are attached. The latter are usually attributed to the action of the muscles drawing them out, and as it were moulding them; but, as Bichât observes, such an opinion, founded on what occurs in soft and inorganic substances, ill accords with the known phenomena of vitality. We observe eminences for the insertion of ligaments, which project more than those which give attachment to muscles; for instance, the spinous process of the ischium: there is, moreover, no proportion between the elongation of different apophyses, and the power of the muscles attached to them, viz. between the styloid process of the temporal bone and its muscles.

The term or phrase "eminence of reflection," is not often used. It expresses a fact which we occasionally observe, viz. that tendons slide upon elevations at the ends of bones, by which their direction is changed. As an instance, we may cite the case of the peronei muscles, and the flexors, which run behind the malleolar projections of the tibia and fibula, by which these tendons take a new direction, and modify the line of traction of their respective muscles.

The prominences on the surface of bones are variously named, according to their form, degree of elevation, and the uses which they serve. When of considerable size, they are called *apophyses* (processus, apophysis, απο from, φυμι to grow). These, in most instances, are appendices to the body or shaft of long bones, in infancy and in early life, when they are called *epiphyses;* but as the process of ossification proceeds to its completion, they become, as it were, soldered to the rest of the bones. The term *tuberosity* (tuber) denotes an eminence, rather broad and rough, but not much projecting; *tubercle* (tuberculum) expresses something still smaller. A process which is thin and tapering, is called *styloid,* from its resemblance to the Roman writing instrument (stylus). A sharp thin projection is called *spine* (spina). But one which runs along like a ridge, is called a *crest* (crista). An apophysis, when rounded, is usually called a *head* (caput), and the constricted part supporting it represents its *neck* (cervix, collum). *Condyle* is a compressed apophysis, which forms part of an articulation.

The depressions and cavities on the external surface of bones are divisible into the articular and non-articular. The former shall be treated of in the section on articulations; the latter, being very numerous, may be ranged under the following heads. 1st, those for insertion; 2nd, for reception; 3rd, gliding; 4th, transmission; 5th, nutrition. Those for "insertion" are well adapted for the attachment of muscle, ligament, &c. by increasing the extent of space allotted for that purpose, inasmuch as a concave surface presents a greater extent than a plane one bounded by the same line. Some of these, as the digastric and pterygoid fossæ, by the greater depth at which they allow the muscles to be inserted, increase their power, by permitting an elongation of their fibres.

The bones of the skull and face present several instances of "cavities of reception." Some correspond with the whole extent of a bone, as in the case of the parietal bone. Some occur in a particular part only, as the fossa in the nasal process of the superior maxillary bone, and os unguis for the lachrymal sac.

The depressions for "gliding" are situated about the heads of long bones, being grooves, in which tendons slide, as they pass to their destinations. The formation of these has been attributed to the influence of the mechanical pressure and friction of tendons. But such a rationale is inadmissible; for they are found in subjects paralytic from infancy, and are by no means proportioned in depth to the force of the muscular exertion which bears upon them. The different configuration of bones should rather be considered as the result of the laws of ossification which preside over the growth and developement of the osseous system, and by which its different parts are adapted to their appropriate purposes.

The cavities for "transmission" give passage to vessels and nerves; their form is various, some being mere fissures, others tubular, &c.; to this head are referrible most of the apertures at the base of the skull.

The foramina of "nutrition" transmit the vessels intended for the support of the substance of the bones and of the medulla; they are divisible into three orders. The first usually receive the name of foramina of nutrition, though in strictness it does not belong to them more than to the others, the only difference between them being, that they transmit vessels to supply the medullary membrane, whilst the others give passage to those which are distributed to the substance of the bone. The first set, con-

siderably the largest, are situated towards the middle of the long bones, and penetrate their substance in an oblique direction. The second order of foramina are much smaller, but very numerous; they are most perceptible towards the extremities of long bones, and generally all over the surface of the short and thick ones. But the third are so minute as to be perceptible only by the aid of a glass, by which we can discern them all over the surface.

The depressions and cavities in bones differ so much in form, size, and use, that it has been deemed necessary to devise certain terms to mark these differences. A deep pit which receives the globular head of a bone, is called a *cotyloid*, or cup-shaped cavity (κοτυλη a cup), or an *acetabulum* (an ancient cup or measure), *ex. gr.* the socket which receives the head of the thigh-bone. If shallow and superficial, it is said to be *glenoid* (γληνη a shallow pit); the articular surface of the scapula upon which the head of the humerus plays, is an instance. A large hollow or cavity in the interior of a bone, is termed a *cave* (antrum), such as that seen in the upper maxillary bone; when of a size smaller, it is known as a *hollow* (sinus), as in the body of the sphenoid bone; and if still smaller, as a *cell* (cellula), as in the orbital process of the palate bone. A small depression is a fovea or fossa. The meaning of the terms canal (canalis), fissure (fissura), notch (incisura), and groove (sulcus), is sufficiently obvious.

Structure.—The proper structure of bone is fibrous in its character; the fibres, in some parts, by being closely aggregated together, constitute a firm and compact substance; but in others they lie so far apart as to enclose spaces or cells, on which depends the porous and spongy appearance of some bones.

The compact substance is so close in its texture, that the naked eye can discover no interstices in it; yet by the aid of a microscope a great number of minute vascular canals become perceptible. In the long bones, these canals are all longitudinal, and maintain a communication laterally with the great medullary canal, and externally with the vessels on the surface of the bone.

The spongy or cellular part presents a multitude of spaces, of various forms and size, all of which communicate with one another, as may be proved by the following experiment; if the end of a long bone, or the surface of a flat one, be perforated, and some mercury poured in, it will be found not only to descend through the cells, but also to flow out through the vascular foramina on the surface. The interior of flat and short bones, then, does not differ so decidedly from that of cylindrical ones, as would at first sight appear. Each presents a cavity, which, at least in the one towards its centre, is a hollow tube, but in the other is divided by a number of intersecting laminæ, into minute spaces communicating freely with one another.

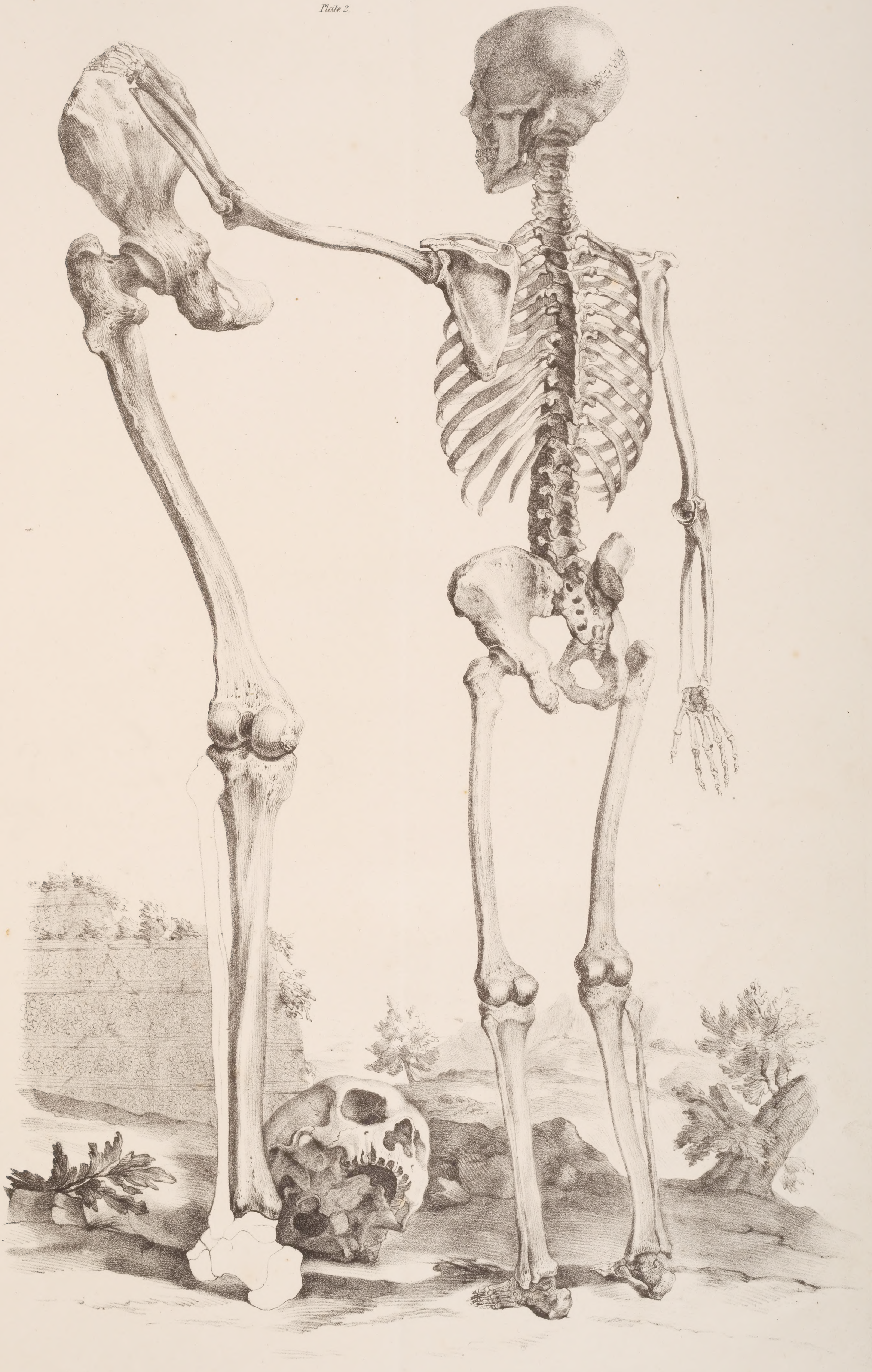
Some peculiarities are observable in the arrangement of the compact and cellular structure in the different classes of bones. The body of long bones consists chiefly of compact substance, but the inner side of the tube is rendered rough by projecting filaments and lamellæ; towards their extremities, the compact substance is gradually reduced to a thin lamella, or layer, encasing the bone, the interior of which consists altogether of cells communicating freely with the central cavity.

The two surfaces of the broad and flat bones are compact in their texture, the interval between them being made up of areolar or spongy substance. This is usually called *diploë*. In its original acceptation the term diploë (διπλοος double) was applied to the two plates or tables of the cranial bones, together with the intervening cellular structure; subsequently it was restricted to the latter part alone; but it is now commonly extended to the loose tissue of all broad and flat bones. The internal table of the cranial bones is more dense than the external, and, from being also more thin and brittle, it is called *vitreous* (tabula vitrea). The short bones are made up for the most part of spongy substance, encased by a thin lamella of compact tissue. These differences arise altogether from the mode of aggregation and arrangement of the osseous particles; for, on examination, the composition of both

PLATE II.

Skeleton of an adult male, posterior aspect; after Cheselden. In describing this figure, Cheselden remarks that it was delineated from "the skeleton of a man five feet and a half high; the left hand resting on the hip of another skeleton, which was near eight feet high." The latter represents a posterior view "of some of the bones of the lower limb of a man, near eight feet high." The skull lying upon the ground he states to have belonged to the same man.

In introducing the bones of the lower extremity in the position represented in the plate, Cheselden seems to have evinced a desire of directing the attention of the student to the obliquity of the femur in relation to the tibia; in order to explain in this way the reason for the greater length of the inner than of the outer condyle.



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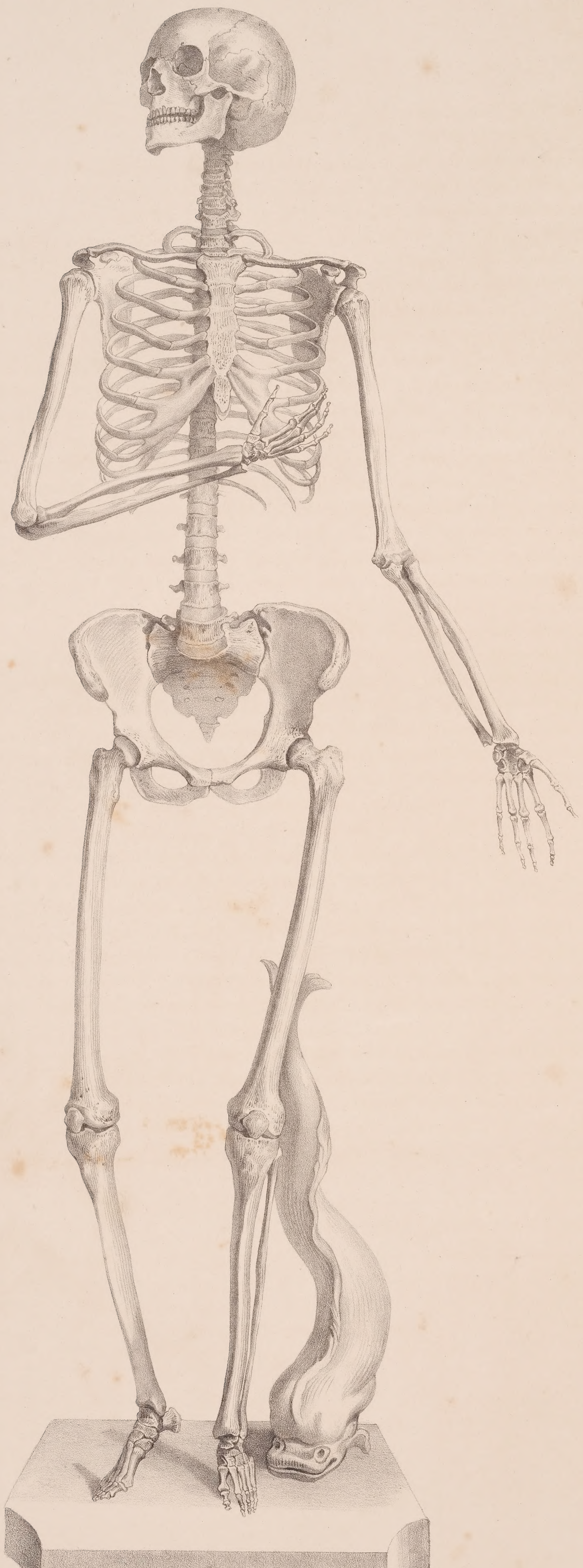
Wm. Fairland litho.

Plate 3.



Wm. Fairland litho.

London, Taylor & Walton, Upper Gower St.

Printed by Fairland.

is found to be the same, being made up of the same elements, viz. a cellular base, in the areolæ of which is deposited a peculiar earthy salt.

These constituents may be separated, so that each may be examined by itself. If a bone be macerated for some days in a dilute acid, the saline or inorganic part is removed, whilst the organic remains; the bone is thus rendered soft and flexible, but retains its form, its weight being diminished in proportion to the quantity of saline matter taken up by the acid: when reduced to this state, it presents no appearance of any particular arrangement of fibres, but by a continued maceration in water it may be resolved into layers, each of which will be found to consist of a series of fibres aggregated together. If the process be still continued, the fibres become swollen and softened, and present an areolar texture, analogous to that of cellular tissue in other parts of the body. This then may be considered as forming the nidus for the deposition of that inorganic substance on which the solidity and firmness of bone depend. If a cylindrical bone be examined in this way, its central portion is found to consist of several laminæ, super-imposed one on the other: the external one is continuous throughout its whole extent, forming its general envelope; but those subjacent to it, as they pass from the centre, become gradually thinner, and turn inwards towards the axis of the bone, becoming continuous with the lamellæ which divide it into areolæ or cells (cancelli, lattice-work). In the flat and irregular bones, the compact structure which encloses them externally sends off filaments and plates to divide their interior into cells.

Examined beneath the microscope, bone is seen to be composed of lamellæ, which are concentric in long, and parallel in flat bones. Between the lamellæ are situated numerous small longitudinal canals, and minute oval corpuscules. The longitudinal canals, named, after their discoverer, "the canals of Havers," contain medullary substance and vessels, and communicate with each other. They also communicate with the medullary canal in the shaft, and with the cells of the cancellous structure in the extremities of long bones and in the interior of flat bones. The canals of Havers are surrounded by minute concentric laminæ, and the latter appear to be crossed by delicate lines which radiate from the area of the canal, to the circumference of the concentric laminæ of each canal. These lines were first observed by Deutsch, who imagines them to be tubes of a prismoid form, and filled with the calcareous substance of bone. In the extremities of long bones, in short, and in flat bones, the cells are the representatives of the Haversian canals, and are analogous in structure, being each surrounded by concentric lamellæ. In like manner, the medullary canal of long bones may be regarded as analogous to one of these Haversian canals, and as representing one of these tubes exceedingly dilated. The oval corpuscules discovered by Purkinje are minute cells, measuring in their long diameter about $\frac{1}{60}$th of a line. From the surface of these cells are given off a number of radiating and branching tubuli, which anastomose with the corresponding tubuli of neighbouring cells. The tubuli were first accurately described by Müller: their larger trunks are about $\frac{1}{3000}$th of a line in diameter; they are, nevertheless, very distinctly seen by means of the microscope. The cells of Purkinje and these tubuli are filled with calcareous substance; hence they have been most appropriately named calcigerous cells and tubuli.

By long-continued boiling, as is well known, a large part of the animal matter of bone is extracted, and a solution obtained, which concretes on cooling into a gelatinous mass. Again, if a bone be exposed to heat so as to expel all the animal matter, it is rendered brittle and light, but still retains its form; but if the heat be raised until the bone becomes red, it undergoes a semi-fusion, as occurs in other earthy substances under the same circumstances. The analysis of bone affords the following results:

According to Fourcroy and Vauquelin.

Animal matter	51
Phosphate of lime	37·7
Carbonate of lime	10
Phosphate of magnesia	1·3
	100

According to Berzelius.

Cartilage	32·17
Blood-vessels	1·13
Fluate of lime	2
Phosphate of lime	51·04
Carbonate of lime	11·30
Phosphate of magnesia	1·16
Soda, muriate of soda, and water	1·20
	100

PLATE III.

Skeleton of an adult female, after Cheselden. This author, in his description of the plate, observes that it presents "the same proportions as the Venus de Medicis."

The general results of these analyses serve to show that the fibrillæ into which bone may be divided by maceration, consist of a cellular tissue, containing in its areolæ a quantity of earthy salts.

Respecting its ultimate fibre, several fanciful notions have been entertained by different persons. Thus, it was considered by some to consist of absorbent vessels, filled with phosphate of lime. Others thought it to be made up of lamellæ and fibres, between which was interposed an osseous juice, &c. Such gratuitous assumptions serve no other end than to lead inquiry out of the true path, and to retard, instead of promoting, the progress of useful knowledge.

Process of Ossification.—Of all the systems of organs, the osseous is that which arrives latest at its full period of developement, the progress of ossification not being fully completed in the different parts of the skeleton until about the sixteenth or eighteenth year; sometimes even still later. From its first commencement to its final completion, the ossific process runs through three distinct states or conditions, viz. the mucous, cartilaginous, and, finally, that of solid bone. But though these succeed one another regularly, it would be a mistake to suppose that the mucous becomes hardened into cartilage, or the latter solidified into bone, by any process similar to transformation; the facts observed by no means warrant such an inference. The change coincides with an alteration in the mode of nutrition in the part, in consequence of which bone is deposited in place of cartilage.

The embryo, at the earliest periods in which it has been examined, presents no distinction of parts, all being equally soft and homogeneous. So, at least, it has appeared to the greater number of those who have investigated the subject. Sir E. Home, however, states that certain parts are distinguishable, even so early as the eighth day after conception. Towards the fourth week, the consistence of the parts corresponding to the future skeleton is sufficiently increased to admit of their being distinguishable from all others, and their outline defined. The vessels, at this period, convey and deposit gelatine, the basis of the cartilaginous state, which appears to be completed about the eighth week, for it is about this period that the deposition of bone begins in some places. The cartilages being temporary substitutes for bone, differ from it in many respects. They present no appearance of fibres or vessels, have no internal cavity or medullary tissue; they are solid and homogeneous in their whole extent, but possess the outward form of bone, and are invested by a fibrous envelope analogous to that of bone (perichondrium). There is another peculiarity which deserves notice: all those parts of the cartilage which are intended to be replaced by flat bones, viz. of the skull, face, and pelvis, represent a continuous layer, without any perceptible boundary or distinction, and the fibrous envelope passes uninterruptedly over the entire surface; but the femur, tibia, clavicle, and humerus are quite distinct and accurately defined: the latter, it will be recollected, are ultimately to be connected by ligaments, and contribute to form the movable articulations; the former still continue to be united by cartilage. About the eighth week, the cartilage, which for a certain time, more or less in different instances, occupies the place and performs the functions of bone, becomes hollowed into irregular cavities, and shortly afterwards into canals lined by vascular membranes, and filled by a mucilaginous or viscid fluid; at this period a red dot appears at some particular point, and ossification immediately commences. The spot first ossified (*punctum ossificationis*) is always situated within the substance of the cartilage, never at its surface. Bichât was of opinion that the vessels were not developed at this period; that they existed before, but circulated only white fluids, and then, for the first time, began to admit red globules; but, be that as it may, the change is marked by the admission of blood into the interior of the cartilage, and the deposition of calcareous matter, both appearing to be coincident. The cartilage appears red and injected, where it is in close contact with the ossified points; more externally it is somewhat opaque, and marked by grooves or canals; in the next remove it retains its original character, presenting, however, in a few points, some vascular canals directed towards the centre of ossification. As the process proceeds, the osseous point increases, as well by additions externally, as by interstitial depositions; whilst the cartilage, as it becomes excavated by canals and cavities lined by vascular lamellæ, diminishes gradually as the bone increases, and finally disappears, being as it were supplanted.

This is to be considered as the general outline of the process of ossification. The time of its commencement and completion varies considerably in different parts of the skeleton. The bones first formed are those which enclose the central organs of circulation, and of the nervous system, the vertebræ and ribs being developed very early. The long bones, viz. clavicle, femur, and tibia,* present along the centre of their shaft a broad ring of bone at the earliest moment at which their outline can be traced, constituting an exception to the general principle, that bone is deposited in the first in-

* Howship, Med. Chir. Transactions.

stance in a bed of cartilage. The jaw-bones and clavicle are also ossified at a very early period; the sternum, pelvis, and extremities being later, which corresponds with the order of their appearance and the date of their growth in the animal series. From the class of fishes, upwards, maxillæ are developed so rapidly as to be completed very early; so are the clavicles when they exist; whilst the sternum, pelvis, and limbs grow tardily, and in many instances remain in a comparatively rudimentary state through life.

In reasoning on the phenomena of ossification, too much has been attributed to the periosteum: its importance and utility cannot be questioned, when we consider how frequently partial exfoliations, or even total necrosis of bones, follow as a consequence of injuries of their fibrous investment. Some persons have, however, gone farther than this, and have even contended that it is the periosteum which produces bone, as if the fibrous membrane acted as its secreting organ; but it may be said that it is its vessels which secrete, and not the membrane. The vessels, however, belong to the bone, not to the periosteum; and moreover, in many parts, the first ossific deposits take place in the centre of cartilage, and therefore at a distance from that membrane.

THE SKELETON.

The osseous structure is peculiarly fitted, by its solidity and hardness, not only to give support to the soft parts, but also to furnish points of attachment to the muscles, by which the different movements are executed. This solid frame-work of the body is made up of a number of separate pieces, the aggregate of which has been termed "*the skeleton*" (sceletum, *σκελλω, to dry*). The vertebral column may be considered as the central or fundamental part of the whole, both because it exists in all animals which possess an internal osseous skeleton, and also because the different parts of the osseous system are either immediately or mediately connected with it as a common centre. Thus, on its superior extremity or apex it supports the skull; laterally it gives attachment to the ribs, which arch forwards, to form, with the sternum, a bony case for the lodgment of the organs of respiration and circulation, at the same time that they furnish externally points of support for the superior extremities: inferiorly the column is immovably connected with the pelvic bones, which are articulated with those of the lower extremity.

When proceeding with the description of the human body, it is usual to consider it as divisible into head, trunk, and extremities, which is sufficient for the purposes of a regional division; but the skeleton must be viewed in a different way, particularly if reference is made to its conformation in the various orders of animals—to its developement—and to the subordination of its component parts. The spine being its essential constituent, all the others (viz. the ribs and sternum, clavicle, scapula, and upper extremities, the pelvic bones and lower extremities,) rank as accessories. The sacrum and coccyx are obviously parts of the spine, so likewise are the cranial bones; for, though in outward appearance they differ so much in man and the higher animals from the bones of the spine which are placed beneath them, and with which they are articulated, they still are but modifications of similar organic elements—repetitions, in fact, of like parts differently developed to suit the peculiar relations into which they enter, and the purposes which they are designed to serve.

The number of pieces which compose the osseous system varies in the different ages of life; for some, which in the first instance are divided into two or more portions, become soldered together as the process of ossification goes on. But authors are far from being unanimous as to the number of bones which they recognise even in the adult. Do the sesamoid bones form part of the skeleton, or are they mere accessory structures developed in tendons? Are the teeth, os hyoides, and ossicula auditûs, to be enumerated as components or accessories? Monro and Sœmmering reckon 260 bones; and Meckel, who takes the number at 253, includes the teeth, patellæ, ossa sesamoidea, os hyoides as five pieces, sternum as three, coccyx as four, and the small bones of the ear. If, however, we omit those just named, as being either accessories or connected with special organs, the whole number of pieces found in the ordinary skeleton will be 197, as follow:—

The spinal column, properly so called, consists of 24 vertebræ, the sacrum and the coccyx, (26).

The skull is made up of eight cranial bones, viz. the occipital, two parietal, two temporal, the frontal, the ethmoid and sphenoid:—and of fourteen facial, viz. two nasal, two lachrymal, two superior maxillary, two malar, two palatal, two turbinated, one vomer, and the inferior maxillary bone, (22).

The ribs are 24 in number (twelve on each side), with the sternum, (25).

The two superior extremities consist each of a clavicle and scapula, humerus, radius, and ulna, eight carpal bones, five metacarpal, and fourteen in the digital rows, (64).

The two inferior extremities comprise, each, one pelvic bone (innominatum), one femur, tibia, and fibula, seven tarsal bones, five metatarsal, and fourteen digital, (60).

In the skeleton we recognise two great cavities (which are again variously subdivided); one anterior and inferior, comprising the thorax and abdomen; the other posterior and superior, formed by the union of the vertebral canal with the cranial cavity.

Vertebral column.—The *vertebral column* (columna vertebralis, rachis, spina,) is situated along the median line, at the posterior part of the trunk, the length of which it determines. Anteriorly it presents the form of an irregular pyramid—posteriorly, a series of elongated processes (spinæ), disposed regularly one beneath the other, from which circumstance the term "spine" is derived. Viewed as a whole, it resembles at first sight the shape of a long bone, but it is very differently constructed. As it receives the weight of the head and trunk, and transmits it to the base on which it rests, it requires to be firm and resisting, its power of resistance increasing gradually from above downwards. Being the centre of all the movements of the body, it must be as pliant and flexible as a bow, but yet firm, in order to give adequate protection to the spinal cord which it encloses. All these conditions are attained by its being made up of several small pieces united by an elastic substance, the motion permitted between each pair being slight, while the aggregate of all is considerable.

PLATE IV.

The bones of the vertebral column articulated.

Fig. 1. The vertebral column seen from the front.

No. 1. The atlas; the number is placed on the anterior arch of this bone. 2, 2. Its superior articular processes. 3, 3. Its inferior articular processes. 4, 4. Its transverse processes. 5. The axis. 6. The base of the odontoid process. 7, 7. The transverse processes, remarkable for their small size as compared with those of the atlas. 8. The body of the third cervical vertebra. 9. The body of the fourth. 10. The body of the fifth cervical vertebra. 11. The sixth cervical vertebra. 12. The seventh cervical vertebra. 13. The anterior tubercles of the transverse processes of the cervical vertebræ. 14. Their posterior tubercles. 15. The body of the first dorsal vertebra. 16. The body of the sixth. 17, 18. The bodies of the eleventh and twelfth dorsal vertebræ. 19, 19. The transverse processes of the dorsal vertebræ. 20, 20. Articular surfaces upon the extremity of the transverse processes. These surfaces are formed on all the transverse processes with the exception of the two last. 21, 21. The transverse processes of the two last dorsal vertebræ, which are remarkable for their small size. 22. The body of the first lumbar vertebra. 23. The last lumbar vertebra. 24, 24. The transverse processes of the lumbar vertebræ, which are long and sharp. 25. The intervertebral substances of the lumbar vertebræ; the same substance is seen between the other vertebræ composing the column. 26, 26. The sacrum. 27, 27. The transverse lines on the sacrum, marking its original conformation of separate pieces. 28, 28. The anterior sacral foramina of one side; the same foramina are seen on the opposite side. 29. The promontory of the sacrum. 30. The first piece of the coccyx, anchylosed to the extremity of the sacrum, and forming a fifth pair of sacral foramina, 31. 32. The lower portion of the coccyx, consisting of three pieces and a rudiment of a fourth.

Fig. 2. A side view of the vertebral column, showing its curves.

No. 1. The atlas. 2. The posterior arch of the atlas. 3. The groove upon which the vertebral artery rests. 4. The axis. 5. The spinous process of the axis, remarkable for its great size. 6. The seventh and last cervical vertebra. 7. The long spinous process of the seventh cervical vertebra. 8, 8. The laminæ of the cervical vertebræ. 9, 9. Their transverse processes. 10. The foramen for the vertebral artery in the transverse process of the axis. 11. The body of the first dorsal vertebra. 12. The body of the sixth dorsal vertebra. 13. The body of the twelfth. 14, 14. The transverse processes of the dorsal vertebræ, upon which the articular depression for the tubercles of the ribs is seen. 15, 15. The spinous processes of the dorsal vertebræ. 16. The intervertebral foramina in the dorsal region of the spine. 17, 17. The intervertebral substances in the dorsal region. 18. Depression upon the side of the body of the first dorsal vertebra, for the first rib. 19, 19. Depressions upon the sides of the bodies of the vertebræ for other ribs. 20. The first lumbar vertebra. 21. The fifth or last lumbar vertebra. 22, 22. The intervertebral substances connecting the bodies of the lumbar vertebræ. 23, 23. Intervertebral foramina in the lumbar region. 24, 24. The transverse processes of the lumbar vertebræ. 25, 25. Articular processes of the lumbar vertebræ. 26, 26. Spinous processes of the lumbar vertebræ. 27. The rudimentary spinous processes of the sacrum. 28. The surface of the sacrum, which articulates with the ilium. 29. The rough portion of the sacro-iliac articulation which gives attachment to the posterior sacro-iliac ligaments. 30. The four pieces of the coccyx.

Fig. 3. Posterior view of the vertebral column.

No. 1. The atlas. 2. The odontoid process of the axis seen articulating with the anterior arch of the atlas. 3, 3. Transverse processes of the atlas. 4. The axis. 5. The seventh cervical vertebra. 6, 6. The bifid spinous processes of the cervical vertebræ. 7. The first dorsal vertebra. 8. The last dorsal vertebra. 9, 9. The articulating processes of the dorsal vertebræ. 10, 10. The short transverse processes of the eleventh and twelfth dorsal vertebræ. 11. The first lumbar vertebra. 12. The fifth lumbar vertebra. 13, 13. The articular processes of the lumbar vertebræ. 14, 14. The sacrum. 15, 15. Its rudimentary spinous processes. 16, 16. The posterior sacral foramina. 17. The commencement of the sacral canal. 18. The termination of the sacral canal. 19, 19. The articular borders of the sacrum. 20. The coccyx.

Plate 4.

Fig. 1.

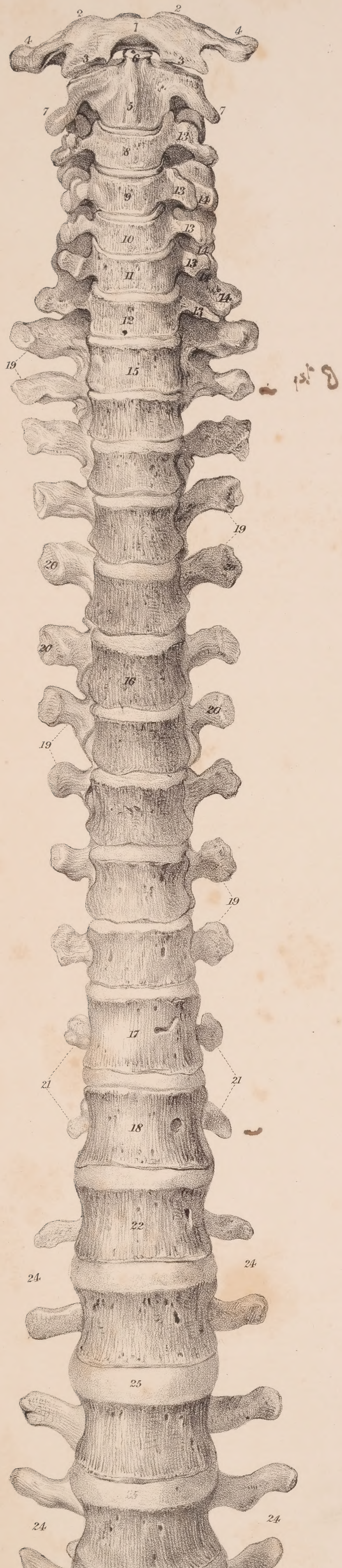
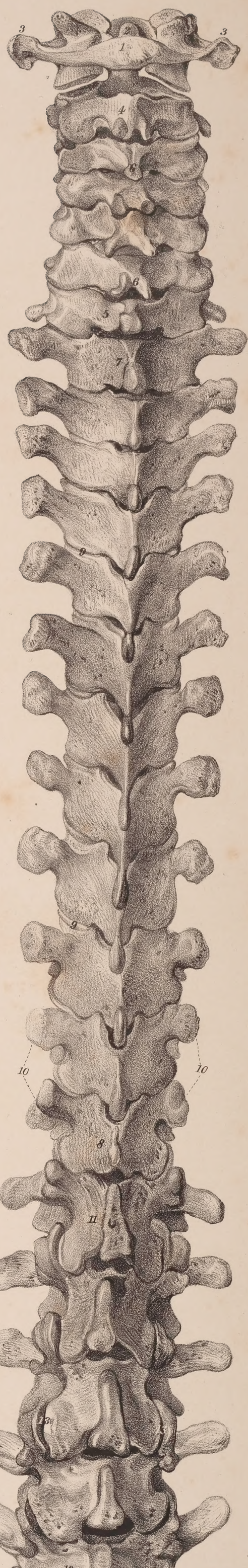


Fig. 2.

Fig. 3.



Wm. Fairland. litho.

London, Taylor & Walton, Upper Gower St.

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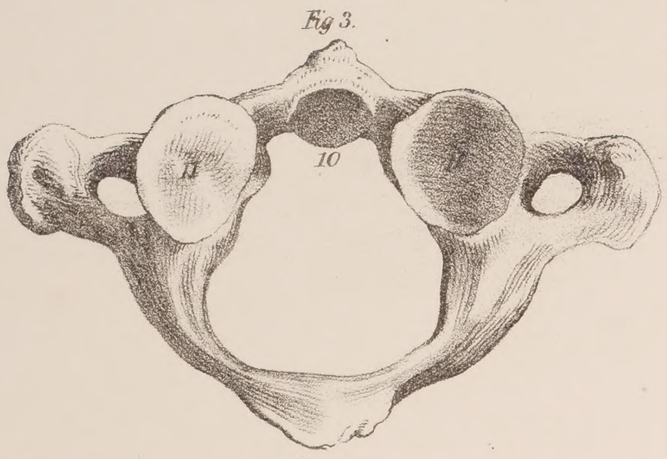
Plate 5.

Fig 3.



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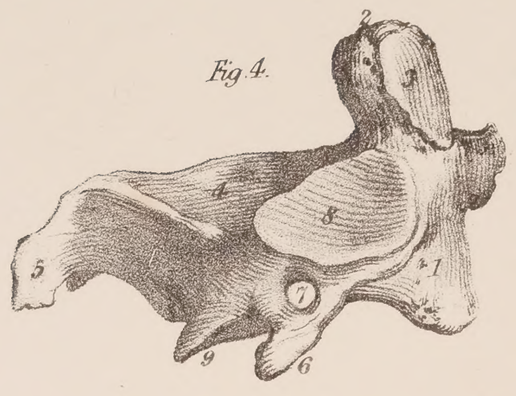

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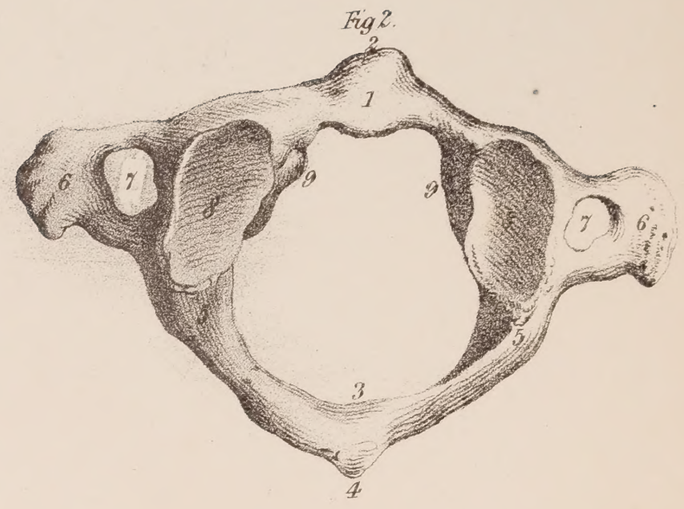

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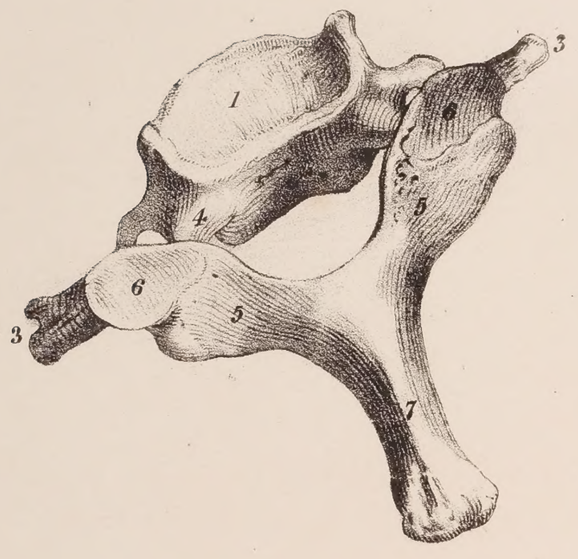

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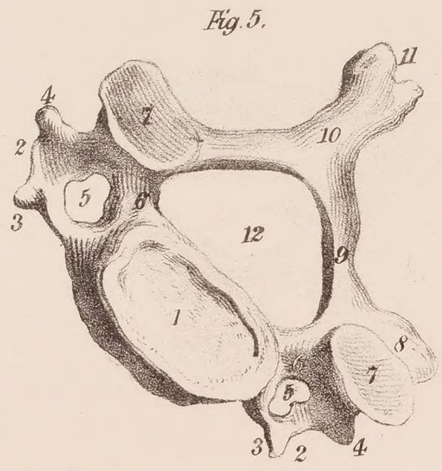
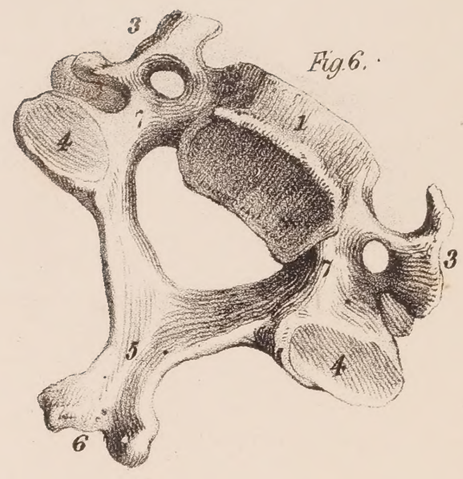


Fig 6.



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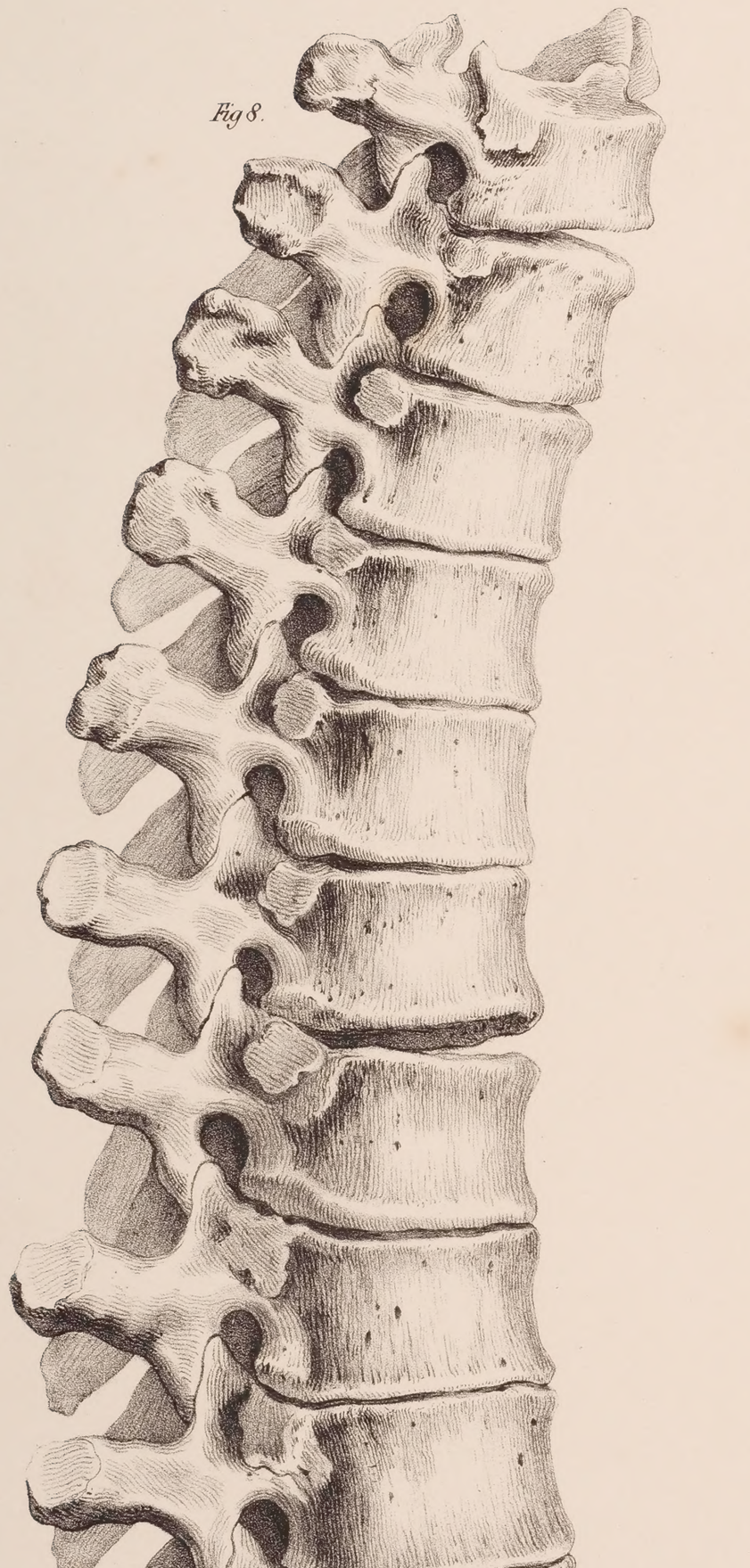

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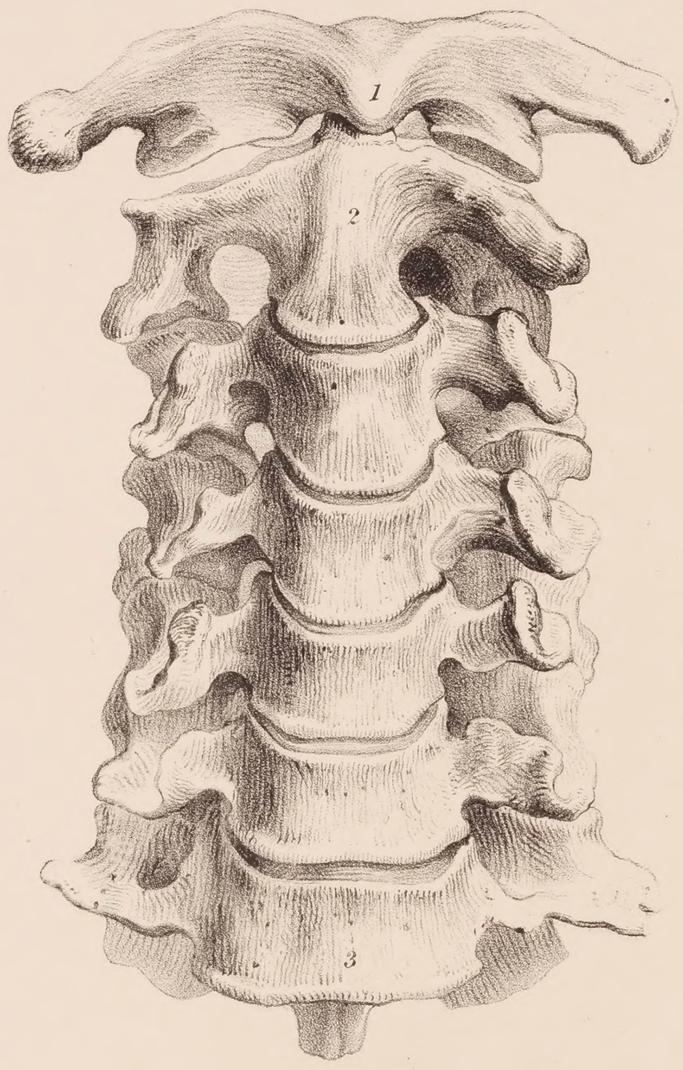

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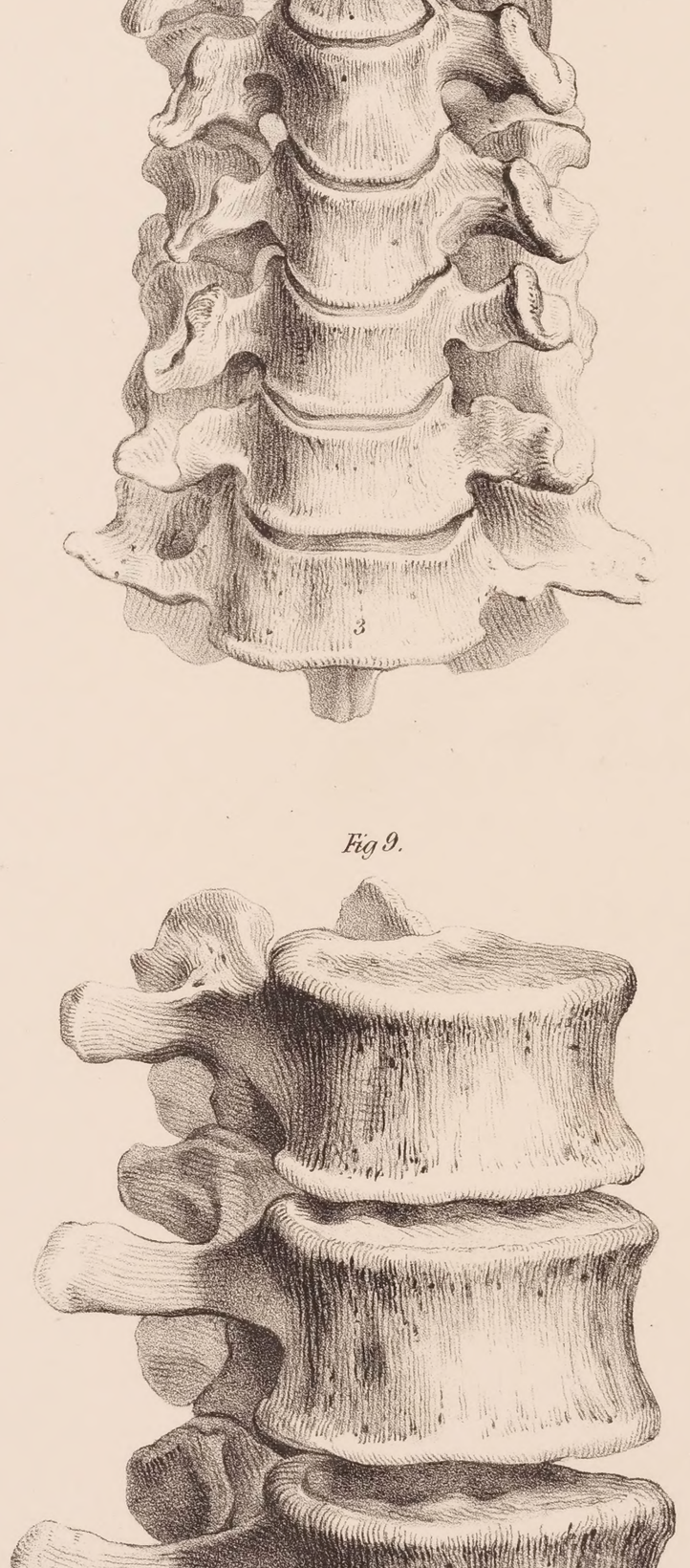

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The *vertebræ*, or separate pieces of which the column is made up, are so named from their mobility (vertere, to turn). They are divided into *true* and *false;* the former term being applied to those which remain separate in the adult, and retain their mobility—the latter to such as become united into one mass (viz. the sacrum), or degenerate as it were, and lose all the ordinary characters of vertebræ (viz. the coccyx). The size of the vertebræ increases from above downwards as far as the first pieces of the sacrum, from which it diminishes towards the end of the coccyx, where it terminates by a point; so that the column may be said to consist of two pyramids applied to one another at their bases. The superior, or movable one, however, does not taper regularly from above downwards in its entire length; it becomes somewhat narrowed and constricted as it were at the third dorsal vertebra, after which it gradually enlarges towards its base.

Vertebræ, division of.—The true vertebræ are divided into three sets, named from the regions which they occupy, *cervical, dorsal, lumbar.* The sacrum and coccyx, which form the remaining part of the column, shall be described with the bones of the pelvis, as they enter into the composition of that cavity, and maintain important relations with the organs which it contains.

The true vertebræ present, 1, certain general characters by which they may at once be distinguished from bones of any other class; 2, those of each region (cervical, dorsal, lumbar,) exhibit peculiar characters by which they are severally distinguished.

General characters of a vertebra.—It is usual to say that a vertebra consists of body and processes —the body being the primary or fundamental part. The objects presented by each of these bones are, a body, a ring, articulating processes, transverse and spinous processes, and notches: of these, the ring, or foramen, merely to suit the purposes of methodical description, may be considered the central part. As the whole series of vertebræ is intended to form a pillar of support, each, with the exception of the first, presents in front a convex mass (the body), which is a section of a cylinder, and which, by being piled one over the other, form the pillar. As each bone must be securely joined with the one

PLATE V.

The vertebræ of the three regions of the spine, with separate vertebræ from the cervical region; after Cheselden.

Fig. 1. A front view of the seven cervical vertebræ articulated.

No. 1. The atlas. 2. The axis. 3. The seventh and last cervical vertebra.

Fig. 2. An atlas seen upon its upper surface.

No. 1. The anterior arch of the atlas. 2. Its anterior tubercle. 3. The posterior arch. 4. The posterior tubercle, or rudimentary spinous process. 5, 5. The intervertebral notch, which supports the vertebral artery at each side. 6, 6. The transverse processes. 7, 7. The foramen for the transmission of the vertebral artery. 8, 8. The superior articular surfaces of the atlas. 9, 9. The tubercles to which the extremities of the transverse ligament are attached.

Fig. 3. The atlas, seen from below.

The references to the preceding figure are equally applicable to this: the additional points exhibited in the present view are, 10. The articular surface for the odontoid process of the axis, on the posterior part of the anterior arch. 11, 11. The inferior articular surfaces, which are flat and nearly horizontal.

Fig. 4. A lateral view of the axis.

No. 1. The body of the axis. 2. The odontoid process of the axis. 3. The smooth articular surface corresponding with the posterior aspect of the anterior arch of the atlas. 4, 4. The laminæ. 5. The spinous process. 6. The transverse process. 7. The foramen for the vertebral artery. 8. One of the superior articular processes. 9. One of the inferior articular processes.

Fig. 5. One of the middle cervical vertebræ, seen upon its upper surface.

No. 1. The body. 2, 2. The transverse processes. 3, 3. The anterior tubercles of the transverse processes. 4, 4. The posterior tubercles. 5, 5. Foramina for the vertebral arteries. 6, 6. The pedicles, rendered concave by the intervertebral notches. 7, 7. Superior articular processes. 8. The outer surface of one of the inferior articular processes. 9, 9. Laminæ of the vertebra. 10. The spinous process. 11. The bifid termination of the spinous process. 12. The ring of the vertebra for the location of the spinal cord with its membranes.

Fig. 6. A cervical vertebra seen upon its under surface.

No. 1. The anterior surface of the body. 2. Its under surface. 3, 3. Transverse processes. 4, 4. The inferior articular processes. 5. The spinous process. 6. Its bifid extremity. 7, 7. The pedicles of the laminæ.

Fig. 7. The seventh cervical vertebra, or vertebra prominens, seen upon its upper surface.

No. 1. The upper and concave surface of the body of the vertebra. 2. Its posterior surface, upon which foramina are seen for the veins of the vertebra. 3, 3. Transverse processes. 4, 4. The pedicles of the laminæ. 5, 5. The laminæ. 6, 6. The superior articular processes. 7. The long spinous process.

Fig. 8. A lateral view of the twelve dorsal vertebræ.

Fig. 9. The five lumbar vertebræ. The vertebræ in the three figures, 1, 8, and 9, constitute together the same vertebral column.

above it, and that below it, there exist certain prominences for articulation with them. The column being flexible, and partaking in the several movements of the body, it is required that there be levers for the attachment of the muscles or moving powers. Finally, it is necessary that a free communication should be allowed for the nerves with the nervous centre contained in the canal.

The *ring* (foramen vertebrale, rachidium,) is formed in front by the body, and posteriorly by what is named the *arch* of the vertebra, from which latter the several processes project. As the vertebræ are piled one over the other, the rings are arranged so as to form, with the aid of the interposed ligamentous structures, a flexible canal for the lodgment and protection of the spinal cord.

The *body* forms the anterior and most considerable part of the bone. Rounded before, and marked in the middle by a transverse groove, which gives it a constricted appearance, it is slightly hollowed posteriorly, where it contributes to the formation of the vertebral canal, and in most instances is flat on the superior and inferior surfaces, by which, through the medium of a layer of fibro-cartilage, it is connected with the contiguous bones. Its outer surface all round presents numerous foramina for the passage of nutritious vessels. From the body, at its lateral margins, two processes pass backwards called "pedicles." The pedicles join with the lamellæ, or plates; and these, by inclining inwards, meet at the median line posteriorly, so as to complete the "arch" of the vertebra. From the point of junction of the pedicles with the lamellæ at each side, the articulating and transverse processes project, and from the union of the two lamellæ the spinous processes take their origin.

Articulating processes.—For maintaining the connexion between the contiguous vertebræ, there are four processes,—two superior, and two inferior,—which project, one on each side, from the junction of the lamella with the pedicle. Two of these processes project upwards, and two downwards; the smooth surfaces of the upper pair look backwards, those of the lower, forwards; they are coated with cartilage, and articulate with corresponding processes of the next vertebræ. Their margins are rough for the attachment of ligaments.

The *transverse* and *spinous* processes form a series of levers for the attachment of muscles. The transverse processes, two in number (one on each side), and named from their direction, project laterally from the arch near the articulating processes, between which their bases are interposed. The *spinous* process is a single projection, situated posteriorly in the median line; this process, or rather the appearance presented by the aggregation of those of the several vertebræ, has given to the entire column one of its designations (spine). The parts of the arch which intervene between the bases of the spinous and the transverse processes are named *laminæ* or *plates*. Lastly, the processes which extend from the lamellæ to the body of the bone, are called "pedicles," as above stated. In each pedicle are seen two excavations, or *notches*, (incisuræ,) one on the upper, the other on the lower border, the latter being deeper than the former. When the vertebræ are placed in their natural position, the notches in the contiguous margins of each pair of them form rounded apertures, which communicate with the vertebral canal, and give transmission to the spinal nerves and to the entering and emerging vessels. From their position and mode of formation they are called the *inter-vertebral foramina* (trous de conjugaison).

These remarks apply generally to all the vertebræ; but as each class presents peculiar characters which distinguish those included within it from others, and as there are peculiarities which mark certain individuals of each class, it becomes necessary to examine them more in detail.

The *cervical* vertebræ are seven in number; they are smaller than those in the other regions, which results from the size of the body and processes being less than that of the corresponding parts in the dorsal and lumbar class. The vertebral foramen is of a triangular form, and larger proportionally than in the other classes. The body, elongated transversely, is thicker anteriorly than posteriorly; for the under and forepart of each dips down a little. The upper surface is broader than the under one, and is rendered concave from side to side, by two little plates, which project upwards from its margins. The lower surface is slightly convex, and rounded off at the sides. The superior articular processes are flat and oblique in their direction, so as to look backwards and upwards, whilst the inferior incline downwards and forwards. The transverse processes short, and bifid at their extremities, present a groove superiorly for the transmission of the nerves, and at their base a foramen, through which in most of them the vertebral artery passes. It will be observed, that these processes have two roots or points of connexion with the vertebra. The posterior one springs from the junction of the pedicle with the arch, and therein corresponds with the transverse processes in the back and loins. The anterior one is attached to the side of the body of the vertebra, and ranges with the ribs, of which it is a rudiment. The formation of the foramen can, from these facts,

be readily indicated. The osseous points, which here represent the ribs, not being required for any special purpose, remain in their rudimentary condition, and merely incline backwards, so as to become anchylosed with the true transverse processes which lie behind them. They thus enclose a space, viz. the foramen, which, however, cannot be said to be intended to lodge the vertebral vessels, as it exists in the seventh cervical vertebra, through which they do not pass, and in the sixth and fifth in those cases in which the artery enters at the fourth. The spinous process is short, projects horizontally backwards, and is bifid at its extremity. The plates are narrower and longer than in the other regions. The notches are deeper and larger in the upper than in the lower border of the pedicles, in all except the second. They lie behind the articular processes in the first, but before them in the rest.

The *dorsal* vertebræ, twelve in number, are intermediate in size, as well as in situation, between the cervical and the lumbar. The foramen is smaller than in the cervical or lumbar region, and is nearly circular in its form. The lateral notches, and consequently the inter-vertebral foramina which they form, are larger than those in the neck; and those at the lower margin of the pedicles are much larger and deeper than those on the upper. The depth of the body, taken from before backwards, is greater than its breadth from side to side; it is convex and prominent on the anterior surface, flat and plain at the upper and lower; at each side of the body may be observed a slight notch, in the superior as well as in the inferior border,—these, when the vertebra is placed in apposition with the adjacent ones, form oval depressions for the reception of the heads of the corresponding ribs. The articulating processes are nearly vertical in their direction; the superior looking backwards, the inferior forwards. The transverse processes are long and inclined backwards, and on the anterior surface of each of their tubercular terminations is situated a slight excavation, which, in the fresh state, is tipped with cartilage, and articulates with the tubercle of the rib. The spinous processes, elongated and triangular, are directed downwards, and terminate in a tubercle. The plates are broad and thick, but shorter than those in the neck.

The *lumbar* vertebræ, five in number, are larger than either of the other sets. The foramen of each vertebra in this region is large and triangular. The notches for the formation of the inter-vertebral foramina are very deep, especially the inferior pair. The body, broader from side to side than from before backwards, is flat on its superior and inferior surfaces. It is not so convex anteriorly as that of the dorsal vertebræ. The articulating processes are thick, strong, and disposed vertically; the superior pair, concave, look inwards and backwards; the inferior, convex, outwards and forwards; the former are farther apart than the latter, hence they receive and in a manner embrace the lower articulating processes of the vertebra above them. The transverse processes, long, thin, and horizontal, do not project backwards like those of the dorsal vertebræ. The spinous process is broad, flat, and nearly of a square form, so that it terminates not by a pointed extremity, like those in the dorsal region, but presents rather a compressed and rough border. The plates, though shorter, are deeper and thicker than those of the dorsal vertebræ.

The general characters of vertebræ, and the differences which characterise those of different regions, being considered, it remains to point out certain peculiarities presented by some individual bones in each set. It may be here stated generally, that the vertebræ situated at the extremities of each region assimilate in some degree to the characters of those in whose vicinity they are placed. Thus, for instance, the lower pieces of the cervical region begin to resemble the dorsal vertebræ, and the latter become, by a similar transition, assimilated to the lumbar,—the characters peculiar to each region being best displayed by the bones situated towards its middle point.

Peculiarities of certain vertebræ.—The first, second, and seventh cervical vertebræ present some characters which distinguish them from the others.

The first, or *atlas*, (so called from supporting the head,) is an irregular ring of bone, which presents nothing analogous either to the bodies or spines of the other vertebræ. The ring, in the fresh state, is divided into two parts, by a transverse ligament,—the anterior one being occupied by the odontoid process of the axis, the posterior by the spinal cord,—it presents in front a small arch of bone, the anterior surface of which is marked by a tubercle; the posterior by a smooth depression, adapted to the odontoid process of the axis. The posterior segment of the ring is considerably larger than the anterior; at its middle point it presents a tubercle, which is the analogue of the spinous processes; it is thick and round in the greater part of its extent; but at its junction with the rest of the vertebra there exists on the upper border at each side a smooth groove, which lies behind the superior articular process, and marks the tortuous course pursued by the vertebral artery previously to entering the cranium. This groove is analogous to the notches in the other vertebræ, for it transmits the first

spinal nerve as well as the vertebral artery; it is sometimes converted into a foramen by a spicula of bone. The articulating surfaces are horizontal and large; the superior pair receive the condyles of the occipital bone; they converge in some sort towards the forepart of the bone; and as their form is oval, and their surface concave from before backwards, they look towards one another; at the inner margin of each is a rough surface, which gives attachment to the transverse ligament. The inferior pair, on the contrary, are flat, and nearly circular in their form. The parts of the vertebra (*lateral masses*) on which these processes are situated are of very considerable thickness, because the weight of the head, which in others is received by the bodies, rests here on the articular surfaces. The transverse processes project considerably on each side, and terminate in a rounded point; at the root of each is situated the foramen, which transmits the vertebral artery.

The second vertebra, or *axis*, (so called from forming the pivot on which the head rotates,) is somewhat triangular in its form. The body presents anteriorly a vertical ridge, bounded on each side by a depression for the attachment of the longus colli muscle; superiorly it is surmounted by a process, (*odontoid, p. dentatus;* whence is derived the name *vertebra dentata,*) presenting two smooth surfaces, one for its articulation with the atlas, the other with the transverse ligament which retains it in its situation; being constricted inferiorly, and somewhat enlarged towards the summit, these parts of the process are called respectively its *neck* and *head.* The superior articulating processes are of considerable size, and nearly horizontal; they are close to the body, so as to communicate to it the weight of the head, transmitted to them by the articular processes of the atlas; the inferior pair are oblique, and of the same size as in the vertebræ beneath them. The transverse processes are neither

PLATE VI.

Section of the vertebral column, showing the texture of the divided surfaces, and the direction of the vertebral canal; with views of the dorsal and lumbar vertebræ: after Cheselden.

Fig. 1. The sixteen superior vertebræ.

No. 1. The atlas. 2. The axis. 3. The seventh cervical vertebra, or vertebra prominens. 4. The first dorsal vertebra. 5. The ninth dorsal vertebra. 6. The most projecting of the spinous processes of the cervical vertebræ, belonging to the vertebra prominens. 7, 7. The oblique direction and imbricated position of the spinous processes of the dorsal vertebræ is here shown. 8, 8. The intervertebral foramina, formed by the approximation of the intervertebral notches. 9, 9. The vertebral canal.

Fig. 2. The eight inferior vertebræ of the spinal column, with the sacrum.

No. 1. The tenth dorsal vertebra. 2. The last dorsal vertebra. 3. The first lumbar vertebra. 4. The last lumbar vertebra. 5, 5. The short and nearly horizontal spinous processes of the last dorsal vertebræ. 6, 6. The broad spinous processes of the lumbar vertebræ. 7, 7. The intervertebral foramina. 8, 8. The vertebral canal. 9, 9. The sacrum. 10. A part of its anterior surface, upon which two of the anterior sacral foramina, 11, 11, are seen. 12, 12. Fissures in the body of the sacrum, marking its original construction of four pieces. 13. Section of the rudimentary spinous processes of the sacrum. 14, 14. The sacral canal, in which several of the posterior sacral foramina, 15, 15, are seen. 16. The termination of the sacral canal. 17. The coccyx, consisting of four pieces.

Fig. 3. A dorsal vertebra seen upon its under surface.

No. 1. The anterior surface of its body. 2. The under surface. 3, 3. Transverse processes. 4, 4. The inferior articular processes. 5. One of the superior articular processes. 6. 6. Laminæ of the vertebra. 7. The vertebral ring. 8. The spinous process. 9. Its tubercle.

Fig. 4. A dorsal vertebra seen from above.

No. 1. The superior surface of the body. 2. Its lateral surface. 3. Part of its posterior surface. 4, 4. The transverse processes. 5, 5. Superior articular processes. 6, 6. Posterior surface of the laminæ. 7. The spinous process, directed downwards and terminated inferiorly by a tubercle.

Fig. 5. The last dorsal vertebra, approaching in appearance to the characters of the lumbar vertebræ.

No. 1. Its body. 2. The depression on the side of the body for the articulation of the last rib. 3, 3. The superior articular processes. 4. One of the inferior articular processes. 5. The pedicle. 6. The superior intervertebral notch. 7. The inferior intervertebral notch. 8, 8. The transverse processes of the vertebra. 9. Its spinous process.

Fig. 6. One of the lumbar vertebræ turned upwards so as to show its under surface.

No. 1. Its body. 2. One of its pedicles. 3, 3. The transverse processes. 4. One of the superior articular processes. 5, 5. The inferior articular processes. 6. The spinous process. 7. The vertebral ring. 8. The under surface of the body.

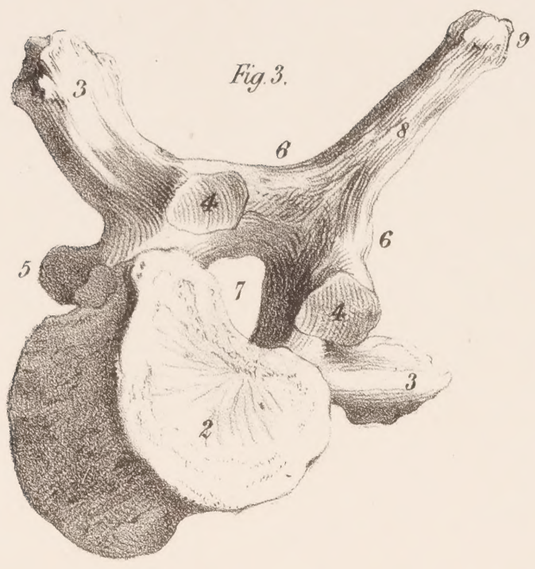
Fig. 7. One of the lumbar vertebræ seen from above and behind.

No. 1. The upper surface of the body of the vertebra. 2. Its posterior surface, on which openings for the transmission of several large veins are seen. 3. The pedicle of one of the laminæ, immediately above which the superior intervertebral notch is seen. 4, 4. Transverse processes. 5, 5. The superior articular processes. 6. One of the inferior articular processes. 7, 7. Laminæ of the vertebra. 8. The spinous process.

Plate 6.

Fig. 1.

Fig. 3.



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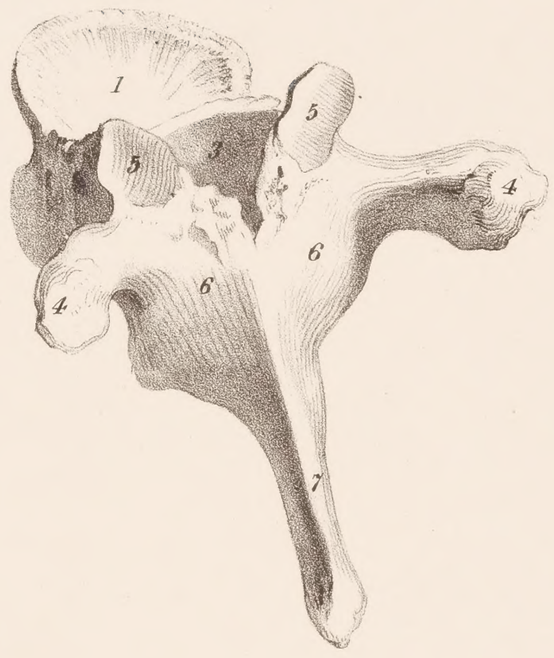

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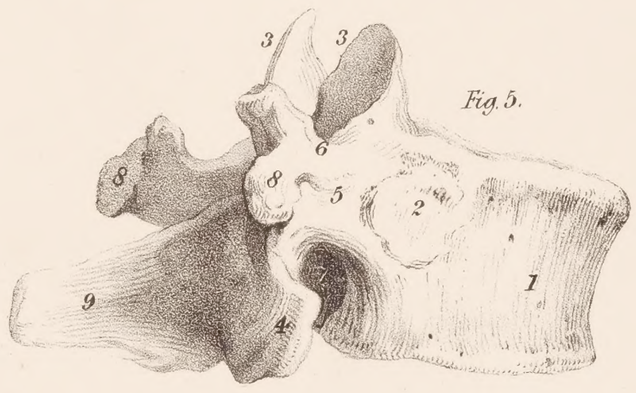

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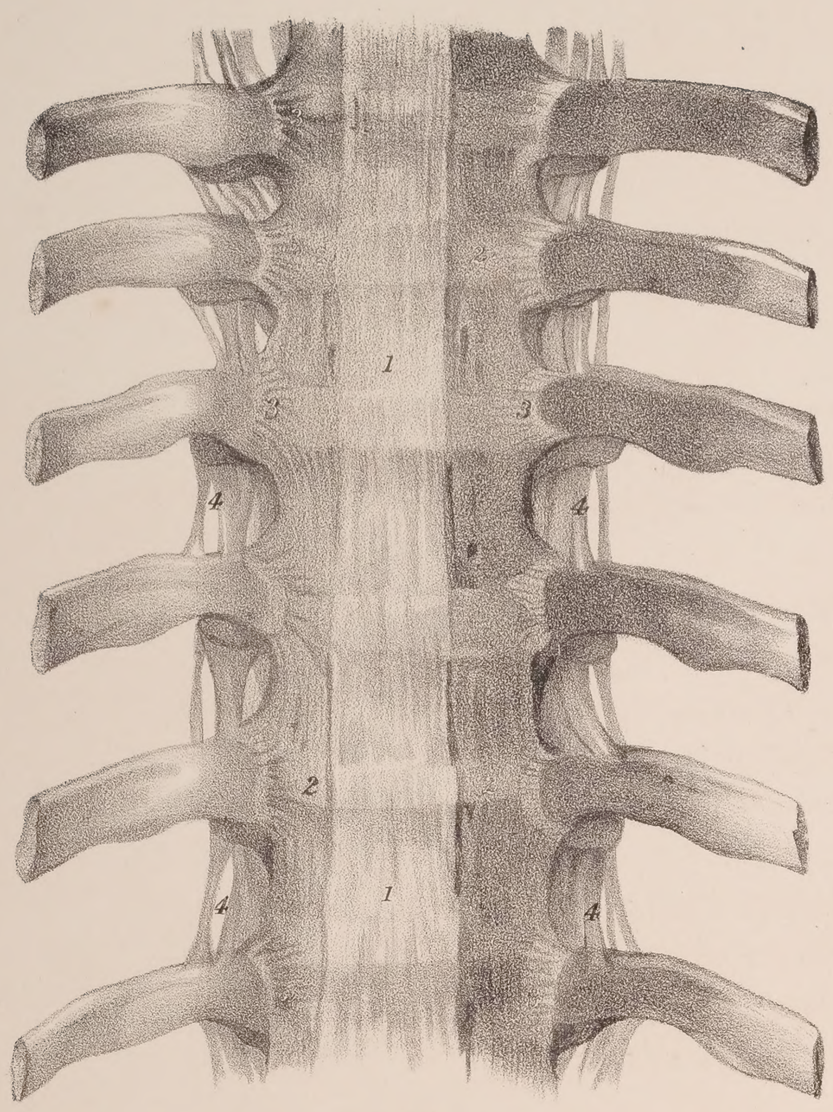
Plate 7.

Fig 1.



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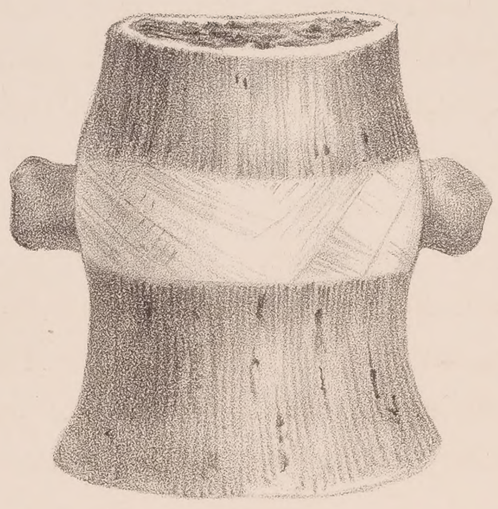

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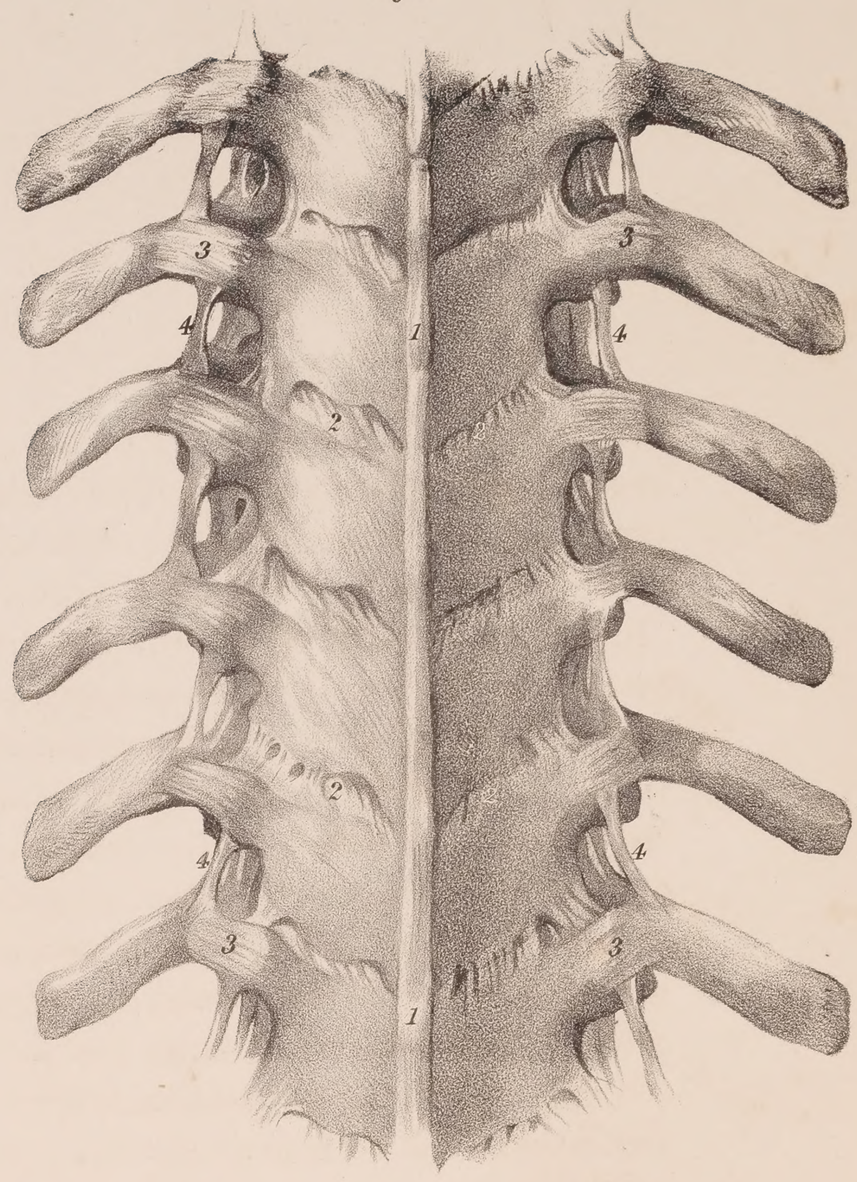

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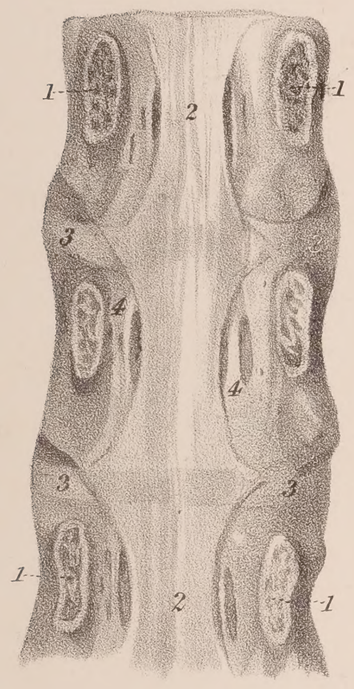

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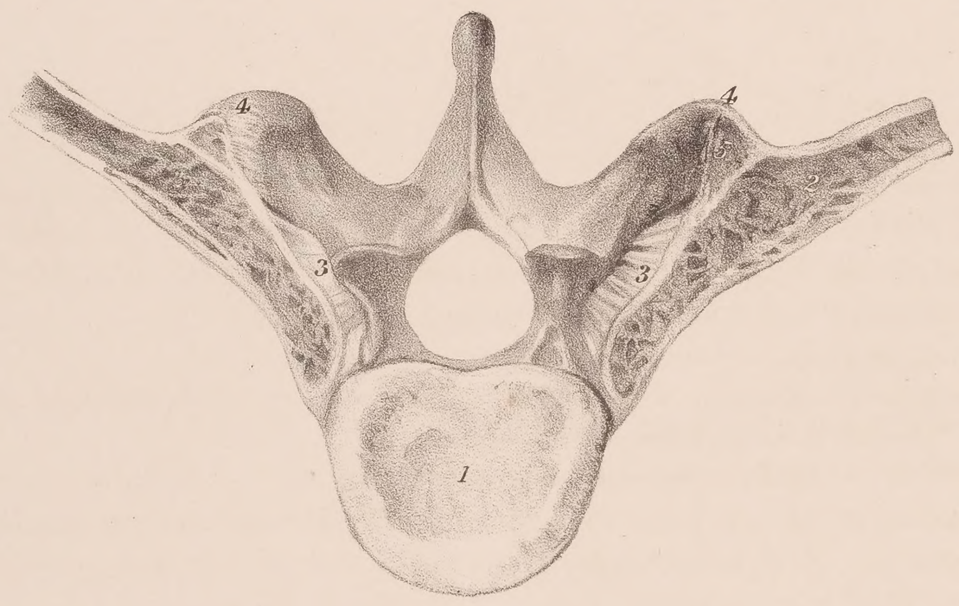

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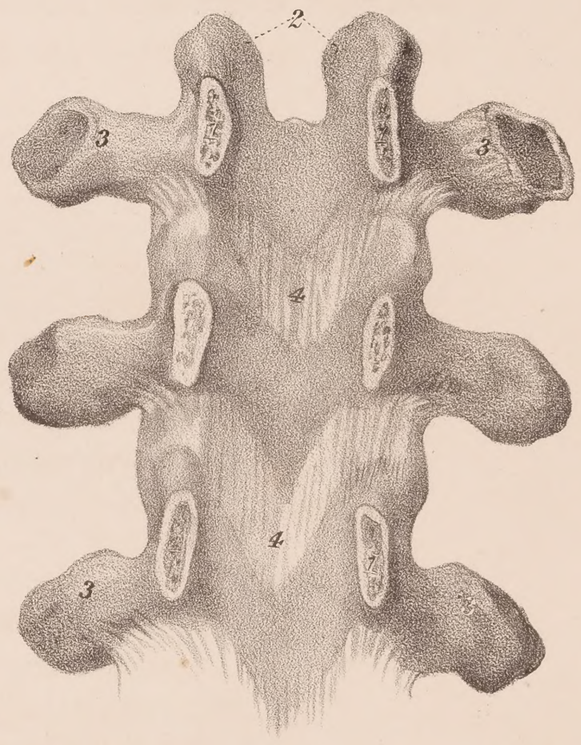

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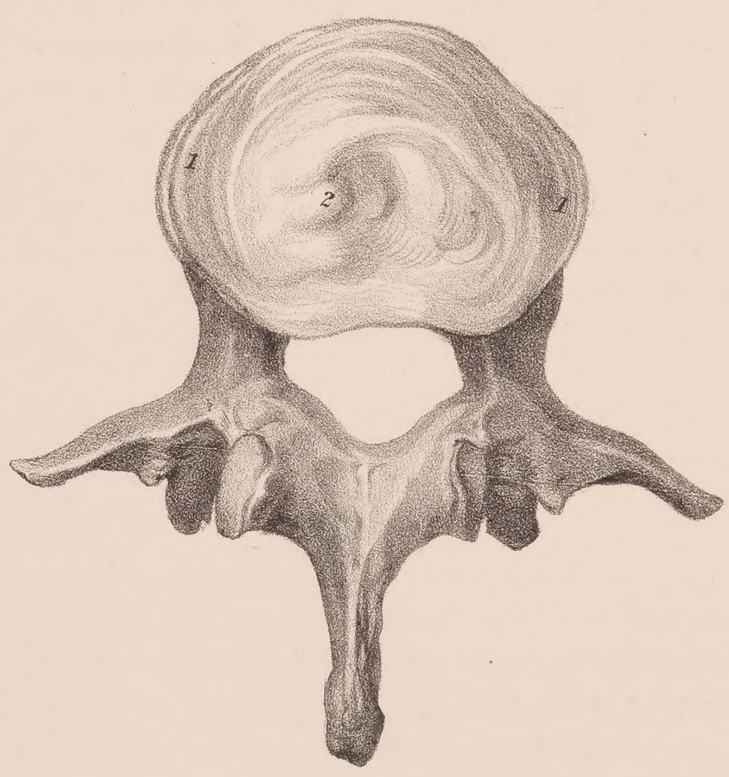

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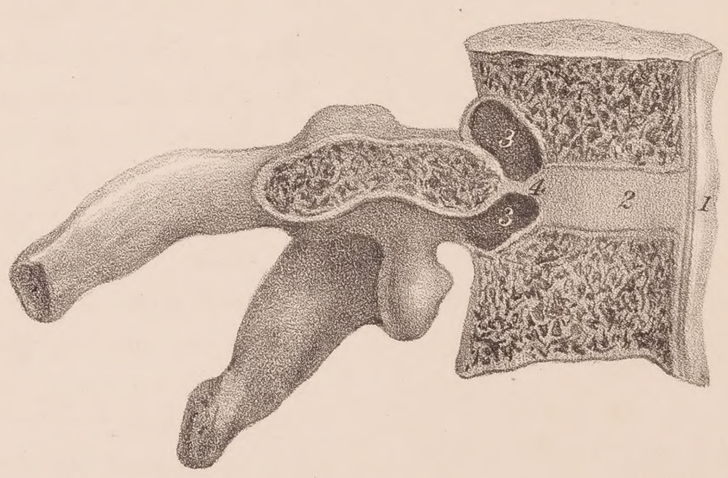

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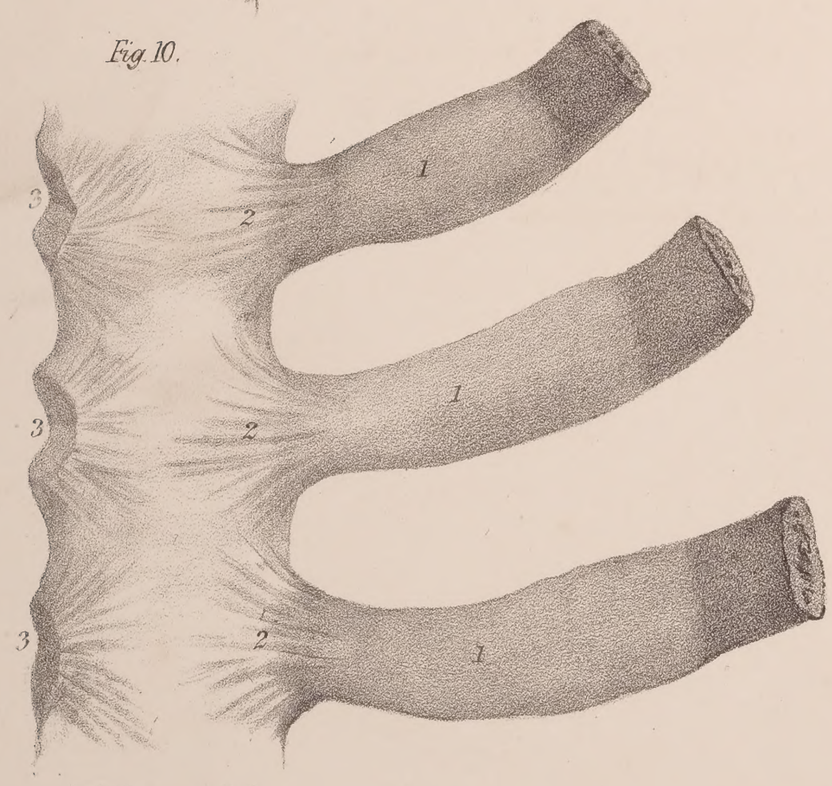

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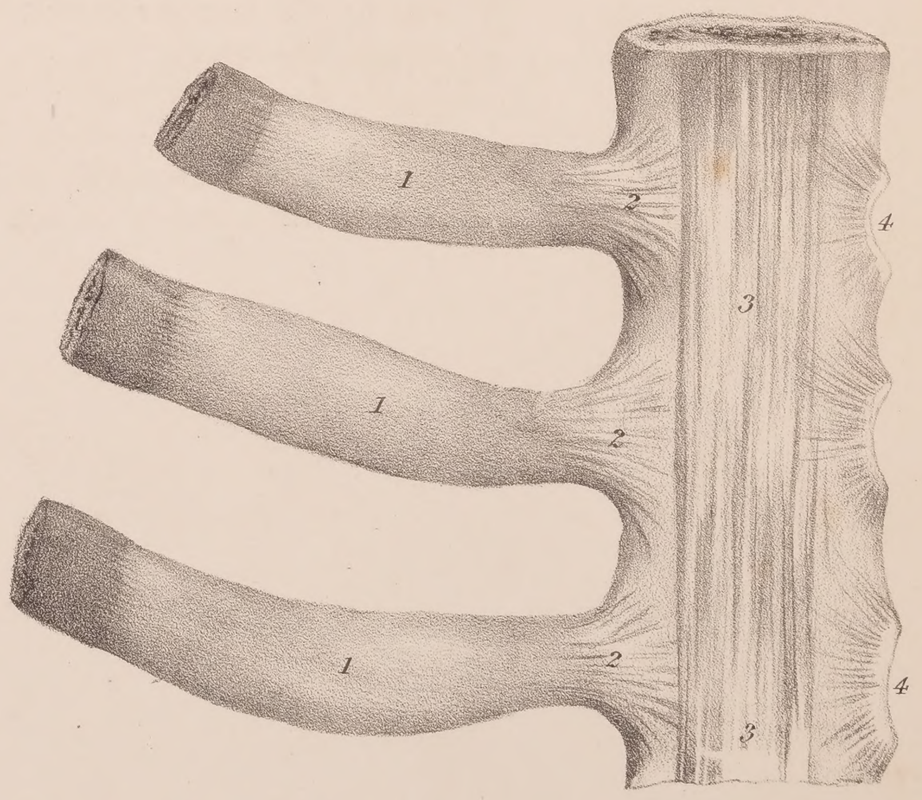

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grooved nor bifurcated, and the foramen at their root is inclined obliquely outwards. The spinous process is very large, and gives attachment to several muscles; it is deeply grooved on its inferior surface; the plates which support it are of proportionate size.

The *seventh*, or prominent vertebra, approaches in its characters to those of the dorsal region; its spinous process terminates in a tubercle, and is so long as to be, in the natural condition, felt underneath the skin, whilst the other cervical spines lie more deeply, and are covered by muscles; hence the term "prominent," so commonly applied to this vertebra. The transverse process, though pierced by a foramen, presents but a slight appearance of a groove on its upper surface, and seldom more than a trace of a bifurcation at its extremity.

The *first dorsal* vertebra is marked at each side by a complete articular surface for the first rib, and on its inferior border by a slight excavation, which receives half the head of the second: the upper articular processes are oblique, and the spinous more nearly horizontal than those below it.

The *tenth* dorsal vertebra is usually marked by an articular surface, which receives the entire of the head of the corresponding rib.

The *eleventh* is distinguished by its transverse processes not presenting an articulating surface for the tubercle of the rib, whilst the form of its spinous process, of its lamellæ and body, approaches that of the lumbar vertebræ.

The *twelfth* dorsal vertebra resembles the eleventh in most of its characters; but its transverse processes are shorter, and the lower articular pair convex and directed outwards, so that its conformation resembles that of the lumbar vertebræ in these particulars.

PLATE VII.

The ligaments of the vertebral column, and of the costo-vertebral and costo-sternal articulations.

Fig. 1. The ligaments situated upon the anterior aspect of the vertebral column, in the dorsal region.

Nos. 1, 1. The anterior common ligament. 2, 2. The intervertebral substances. 3, 3. The anterior costo-vertebral or stellate ligaments. 4, 4. The anterior costo-transverse ligaments.

Fig. 2. The ligaments of the posterior aspect of the vertebral column.

Nos. 1, 1. The supra-spinous ligaments. 2, 2. The ligamenta subflava. 3, 3. The posterior costo-transverse ligaments. 4, 4. The anterior costo-transverse ligaments.

Fig. 3. A posterior view of the bodies of three of the dorsal vertebræ.

Nos. 1, 1. The cut surfaces of the pedicles of the vertebræ. 2, 2. The posterior common ligament. 3, 3. The intervertebral substances. 4, 4. Foramina for the transmission of the venæ basis vertebræ.

Fig. 4. Arches of three of the dorsal vertebræ.

Nos. 1, 1. The cut surfaces of the pedicles. 2. Superior articular processes of the uppermost of the three. 3, 3. Transverse processes. 4, 4. Ligamenta subflava.

Fig. 5. The intervertebral substance between two vertebræ, showing its composition of oblique fasciculi of fibres.

Fig. 6. The surface of a section of the intervertebral substance.

Nos. 1, 1. Concentric circles of fibrous structure. 2. The pulpy fibro-cartilaginous tissue of the centre of the intervertebral substance.

Fig. 7. A lateral view of the ligaments of the vertebral column, with those of the costo-vertebral articulation.

Nos. 1, 1. The anterior common ligament. 2, 2. The intervertebral substances. 3, 3. The anterior costo-vertebral or stellate ligaments; the numbers are placed on the middle fasciculi. 4. The superior fasciculus of the stellate ligament. 5. Its inferior fasciculus. 6, 6. The anterior costo-transverse ligaments. 7. The articular facets of two adjoining vertebræ, serving for the articulation of a single rib. The numeral is placed upon the intervertebral substance, which serves for the attachment of the interarticular ligament. 8. The articular surface at the extremity of the transverse process, for the attachment of the same rib. 9. The supra-spinous ligaments. 10. One of the inter-spinous ligaments.

Fig. 8. A vertebra, with its articulated ribs, seen from above, in order to show the middle costo-transverse ligament.

No. 1. The surface of the body of the vertebra, coated with intervertebral substance. 2, 2. The ribs divided through their middle. 3, 3. The middle costo-transverse ligament. 4, 4. The posterior costo-transverse ligaments. On the left side, at 5, the articulation of the tubercle of the rib with the transverse process is partly laid open.

Fig. 9. Section of a vertebra with the head of a rib, through the costo-vertebral articulation.

No. 1. Part of the anterior common ligament. 2. The intervertebral substance. 3, 3. The two synovial cavities of the costo-vertebral articulation, separated by 4, the interarticular ligament.

Fig. 10. The costo-sternal articulation seen from the front.

Nos. 1, 1. Cartilages of the ribs. 2, 2. Anterior costo-sternal ligaments. 3, 3. Articular surfaces of the sternum, for the costal cartilages of the opposite side.

Fig. 11. The costo-sternal articulation, seen from behind.

Nos. 1, 1. Costal cartilages. 2, 2. Posterior costo-sternal ligaments. 3, 3. Longitudinal tendinous fibres on the posterior surface of the sternum. 4, 4. Articular surfaces of the opposite border of the sternum.

Amongst the *lumbar* vertebræ, the fifth only is distinguishable by any peculiarity deserving of notice, its body being thicker anteriorly than posteriorly, and its transverse process short, thick, and rounded.

The bones just described, when ranged in their natural position, form a pyramid, the length of which is equal to about two feet two or three inches; taken as a whole it presents an anterior and posterior surface, two lateral surfaces, a base, and a summit, each deserving a particular notice.

The anterior surface is broad in the cervical, narrow in the dorsal, and again expanded in the lumbar region; it is marked by a series of transverse grooves corresponding with the centre of the bodies of the vertebræ, and in the fresh state is covered by the anterior common ligament. When viewed in profile, it presents three curves depending on the different degrees of thickness of the anterior and posterior part of the bodies of the vertebræ in the different regions, but still more on that of the inter-vertebral substance. In the neck and loins the convexity of the curve is forwards; in the back it is in the opposite direction. A slight degree of lateral curvature is also observable in most cases in the dorsal region, the convexity of which is directed towards the right side. The older anatomists imagined this to be produced by the action of the aorta beating against the left side of the column; but Bichât attributed it to the effect of muscular action, and explained it in the following way:—As most persons are disposed to use the right arm in preference to the left, the muscles of that side become stronger, and act with more power on the points to which they are attached; when making efforts, as in pulling, the body is curved to the left, which gives an additional advantage to the muscles; and the habitual use of this position gives rise to some degree of permanent curvature. In support of this explanation of the fact, Béclard has stated that he found in one or two individuals, who were known to have been left-handed, the convexity of the lateral curve directed to the left side.

The posterior surface presents along the median line the spinous processes, varying in form and direction, as has been already stated; being horizontal in the cervical and lumbar regions, and nearly vertical in the dorsal. Those in the cervical and dorsal regions correspond pretty exactly with the middle line, but in the back the spines will be observed in many instances to incline, some to one side, some to the other. On each side of these are the vertebral grooves, extending from the base of the skull to the sacrum; their breadth corresponds with that of the laminæ; they are broad but shallow in the neck, and become deep and narrow lower down. Along the grooves are seen the spaces between the laminæ, which in the natural condition are filled up by the yellow ligaments. The breadth of these intervals is very trifling in the neck and in the greater part of the back; it increases in the lower third of the dorsal, and still more in the lumbar region. The interval between the occipital bone and the atlas is considerable, and so is that between the last lumbar vertebra and the sacrum.

The lateral surfaces of the column present the transverse processes, varying in form and character in the different regions; before these are situated the inter-vertebral foramina, and more anteriorly still, in the dorsal region, the articulating surfaces which receive the heads of the ribs.

The summit is articulated with the occipital bone, and supports the head; whilst the base, or broader extremity, rests on the sacrum. Along the entire extent of the column runs the vertebral canal, which is broad and triangular in the cervical and lumbar regions, circular and contracted in the dorsal. The canal may be said to expand at its upper extremity into the cranial cavity, and at its lower end to be prolonged into that of the sacrum.

Developement.—In the description here given of the vertebræ, each of them is considered as a single bone; and so it is when fully formed. But in the fœtal state and in early infancy each consists of at least three pieces, representing so many centres of ossification, one corresponding with the body and one for each lateral mass. The spinous process has even been observed to commence by a separate point, and analogy would lead to the inference that the anterior and posterior segments of the body are produced from distinct centres. Are we to go farther still, and admit that the body in the first instance consists of two lateral halves? If so, instead of three, we should have eight incipient osseous points in each of these bones. The atlas has three osseous nodules from which its ring is completed, one at each side for the lateral masses, and one in front for the anterior arch. Bichât found in some cases two additional points in the posterior arch. The second vertebra commences by five points at least, two of them being in its odontoid process.

Of the Skull.—The skull is of a spheroidal figure, compressed on the sides, broader behind than before, and supported by its base on the vertebral column. It is divided by anatomists into two parts, the cranium and the face; the former being composed of eight bones, viz. the *occipital*, two *parietal*, the *frontal*, two *temporal*, the *sphenoid*, and the *ethmoid*; the latter is made up of fourteen bones, viz. two *superior maxillary*, two *malar*, two *ossa nasi*, two *ossa palati*, two *ossa unguis*, two *inferior turbinated*

bones, the *vomer*, and *inferior maxilla;* the frontal bone is so situated as to be common to the cranium and face. The bones of the ear are not included in this enumeration, as they belong rather to a special organ than to the skeleton considered as the frame-work of the body.

The Occipital Bone.—The occipital bone (os occipitis) is situated at the posterior part of the base of the skull; broad behind, narrowed to a point before, of a trapezoid figure, presenting two surfaces, four borders, and four angles. To place the bone in its natural position, hold it so that the great foramen and the articulating processes beside it shall look directly downwards; the thick process in front of the foramen will then project forwards into the base of the skull, whilst the broad expanded part behind it arches upwards and a little forwards, forming the posterior wall of the cavity. *External surface:* this is convex in its general outline, and presents a little above its centre a rough prominence, the *occipital protuberance*, the part between which and the superior angle is smooth. Extending obliquely outwards at each side from the protuberance is a rough line, called the *superior curved line*, to distinguish it from another which is lower down between it and the great foramen, called the *inferior curved line;* both are prominent, and give attachment to muscles, as also do the rough depressions between them. These are crossed by a vertical line, extending forwards from the protuberance to the foramen.

The *occipital foramen*, (foramen magnum,) which is of an oval figure (its long diameter extending from before backwards), gives transmission to the spinal cord, the vertebral arteries, and spinal accessory nerves.

At each side of the foramen, but nearer its anterior part, are situated the articulating processes, (*condyles*,) two oblong eminences, which articulate with the first vertebra. These converge from behind forwards; their inferior surface, which in the fresh state is smooth, covered with cartilage, and convex in its general outline, looks downwards and outwards, and is adapted for moving on the concave surface presented by the articulating processes of the atlas. The inner border of each condyle is rough, and receives the insertion of the check ligaments, which extend up from the odontoid process of the axis; the outer border, depressed and not so well marked, gives attachment to the ligament connecting it with the atlas.

External to the forepart of the condyles are two fossæ, in the bottom of which are two foramina, (*anterior condyloid*,) which look outwards and forwards, and transmit the hypoglossal nerves; behind them are also two larger pits, in which are generally, but not always, found foramina, (*posterior condyloid*,) which give passage to a vein and small artery: sometimes a foramen exists at one side, and not at the other. External to each condyle is a rough surface, which overhangs the transverse processes of the vertebræ, and of which it may be regarded as the "analogue;" it gives insertion to the rectus lateralis muscle.

The *internal surface* of the bone is marked by two lines—one vertical, extending from the upper angle of the bone to the great foramen, and the other transverse from one lateral angle to the other. These intersect towards the central point, (internal occipital protuberance,) and mark off four pits, of which the upper pair (superior occipital fossæ) receive the posterior lobes of the brain, and the lower (inferior occipital fossæ) lodge the lateral lobes of the cerebellum: the superior line and the two transverse ones are generally grooved, and correspond with the course of the longitudinal and lateral sinuses. The inferior one gives attachment to the falx cerebelli. The anterior border of the foramen magnum is slightly excavated, and becomes continuous with the *basilar groove*, a shallow excavation on the surface of the basilar process, which supports the medulla oblongata; close to the margin of the foramen are the anterior condyloid foramina, and a little external to it are two fossæ, marking the terminations of the lateral sinuses.

The thick triangular process, which projects forwards into the base of the skull from the foramen, is called the *basilar* process; its margins are rough, and contiguous to the pars petrosa of the temporal bone; its under surface presents slight depressions for the insertion of muscles, and the upper one the shallow groove just noticed.

The *superior borders* of the occipital bone are dentated and converge to a point, but are frequently interrupted by bony islets (ossa triquetra—Wormiana); the inferior border at each side is divided into two parts by a prominent piece of bone, the *jugal eminence*, which surmounts an excavation contributing with the temporal bone to form the jugular fossa. The superior angle is acute, and received into the retiring angle formed by the posterior border of the parietal bones; the anterior is represented by the extremity of the basilar process; the lateral angles, not very prominent, correspond with the line at which the postero-inferior angle of the parietal bone joins with the mastoid part of the temporal.

Articulations.—The occipital articulates with six bones, viz. with the two parietal by its superior borders—the two temporal by the inferior—with the sphenoid by its basilar process—and with the atlas by the condyles.

PLATE VIII.

Ligaments of the articulations between the occipital bone, the atlas and the axis, and of the lower jaw.

Fig. 1. The ligaments connecting the occipital bone, the atlas and the axis, seen from the anterior aspect.

No. 1. Section of the basilar process of the occipital bone. 2, 2. Sections of the extremity of the petrous portion of the temporal bones. 3, 3. The transverse processes of the atlas. 4, 4. The axis. 5, 5. The third cervical vertebra. 6. The round, or accessory anterior occipito-atloidean ligament. 7, 7. The broad anterior occipito-atloidean ligament. 8, 8. Capsular ligaments of the occipito-atloidean articulation. 9, 9. The anterior atlo-axoid ligament. 10, 10. Capsular ligaments of the atlo-axoid articulation: on the right side the articulation is laid open, in order to show the articulating surfaces. 11, 11. Capsular ligaments of the articulation between the second and third vertebræ. 12. The commencement of the anterior common ligament.

Fig. 2. The ligaments of the occipital bone, the atlas and the axis, seen from behind.

No. 1. A part of the occipital bone. 2. The posterior arch of the atlas. 3, 3. Its transverse processes. 4. The spinous process of the axis. 5, 5. Its laminæ. 6, 6. Its rudimentary transverse processes. 7, 7. The third cervical vertebra. 8. The posterior occipito-atloidean ligament. 9, 9. The vertebral arteries, passing beneath an arch at each side, formed by this ligament. 10. The posterior atlo-axoidean ligament. 11, 11. The atlo-axoidean capsular ligaments. 12. One of the capsular ligaments of the articulation between the second and third vertebræ; the other, 13, is laid open.

Fig. 3. The upper part of the vertebral canal, opened from behind by removing a part of the arches of the vertebræ, in order to show the occipito-axoidean ligament.

No. 1. The basilar portion of the sphenoid bone. 2, 2. The foramen lacerum posterius. 3, 3. The anterior condyloid foramina. 4, 4. The occipito-axoidean ligament. 5. A slight projection of this ligament, formed by the odontoid process. 6, 6. The cut surfaces of the posterior arch of the atlas. 7, 7. The transverse processes of the atlas. 8, 8. The capsular ligaments of the occipito-atloidean articulation. 9, 9. The cut extremities of the laminæ of the axis. 10, 10. The capsular ligaments of the articulation between the axis and the third cervical vertebra.

Fig. 4. The ligaments brought into view on the removal of the occipito-axoidean ligament. The section is the same as in the preceding figure.

No. 1. A small portion of the occipito-axoidean ligament. 2. The transverse ligament of the atlas. 3, 3. The vertical fibres of the transverse ligament, which have gained for it the designation of the cruciform ligament. 4, 4. The odontoid ligaments, connecting the apex of the odontoid process with the inner surface of the condyles of the occipital bone. 5, 5. Occipito-atloidean capsular ligaments. 6, 6. Capsular ligaments of the articulation between the axis and the third cervical vertebra.

Fig. 5. The ligaments of the occipital bone, atlas and axis, examined by means of a vertical section.

No. 1. The internal surface of a part of the base of the skull lined by dura mater. 2. One of the anterior condyloid foramina. 3. Section of the basilar process of the occipital bone. 4. Section of the posterior part of the occipital bone. 5. The cut surface of the anterior arch of the atlas. 6. The cut surface of the posterior arch. 7. Vertical section of the body of the axis and of the odontoid process. 8. Cut surface of its arch. 9, 9. Section of the third cervical vertebra. 10. Section of the anterior occipito-atloid ligament. 11. Section of the transverse ligament. 12. The superior vertical fasciculus of the transverse ligament. 13. The inferior vertical fasciculus of the transverse ligament. 14, 14. The occipito-axoidean ligament. 15. The fan-shaped insertion of the right odontoid ligament. 16. The posterior occipito-atloidean ligament. 17. The right vertebral artery, passing beneath a tendinous arch formed by the posterior occipito-atloidean ligament. 18. Section of the anterior atlo-axoidean ligament. 19. The posterior atlo-axoidean ligament. 20. The commencement of the anterior common ligament. 21. Intervertebral substance between the bodies of the second and third cervical vertebræ. 22. The first ligamentum subflavum.

Fig. 6. The atlas, seen from above, showing the situation of the transverse ligament, and the opening for the reception of the odontoid process of the axis.

No. 1. The anterior arch of the atlas. 2. Its posterior arch. 3, 3. The lateral masses upon which the articular surfaces for the reception of the condyles of the occipital bone are seen. 4, 4. The transverse processes pierced by the foramina for the passage of the vertebral arteries. 5. The transverse ligament. 6. The opening for the reception of the odontoid process. 7. The posterior opening of the ring of the atlas for the transmission of the spinal cord and its membranes.

Fig. 7. The articulation of the lower jaw seen from the external surface.

No. 1. A portion of the malar bone. 2. The zygoma. 3. The tubercle of the zygoma, which gives attachment to the external lateral ligament. 4. The external lateral ligament. 5. The neck of the lower jaw. 6. Its ramus. 7. Its coronoid process. 8. A part of the superior maxillary bone. 9. The mastoid process of the temporal bone. 10. The meatus auditorius externus. 11. The styloid process. 12. The stylo-maxillary ligament.

Fig. 8. The articulation of the lower jaw seen from within.

Nos. 1, 1. The cut surface of a section, including a part of the occipital, the petrous portion of the temporal, and the spinous process of the sphenoid bone. 2. The internal surface of the mastoid process. 3. The styloid process. 4. The stylo-maxillary ligament. 5. The ramus of the lower jaw. 6. The internal lateral ligament of the articulation of the lower jaw. 7. The small arched opening which transmits the mylo-hyoidean nerve. 8. The neck of the lower jaw. 9. Its coronoid process.

Fig. 9. A vertical section carried through the middle of the articulation of the lower jaw.

Nos. 1, 1. Section of the temporal bone. 2. The interarticular fibro-cartilage dividing the joint into two synovial cavities. 3. The superior synovial cavity. 4. The inferior synovial cavity. 5. Cut surface of the head of the lower jaw. 6. Ramus of the lower jaw. 7. Its coronoid process. 8. Its angle. 9. The styloid process of the temporal bone. 10. The stylo-maxillary ligament. 11. The internal surface of the mastoid process.

Fig. 10. An interarticular fibro-cartilage removed from the articulation.

Fig. 11. An interarticular fibro-cartilage pierced through its middle by a foramen, as is sometimes observed.

Plate 8.

Fig. 1.

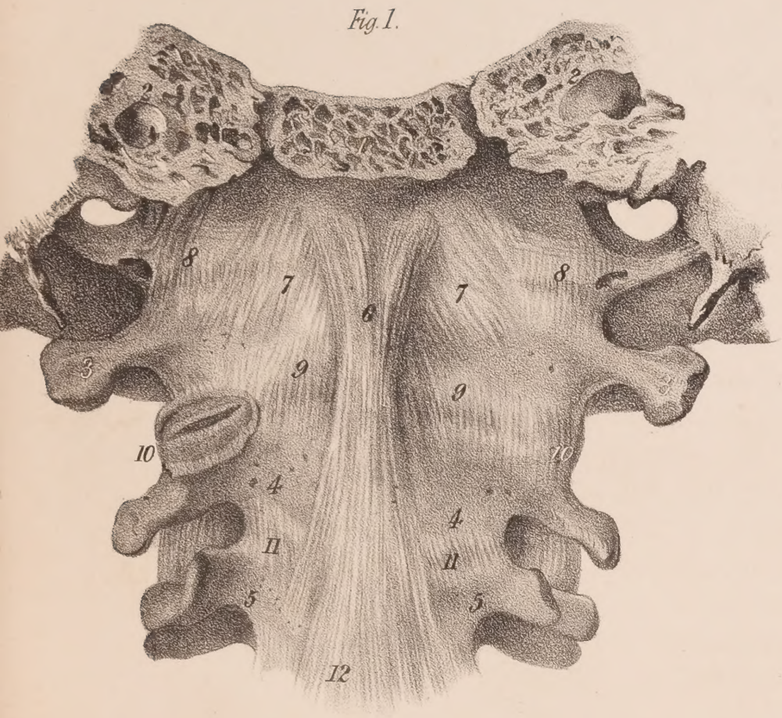


Fig. 7.

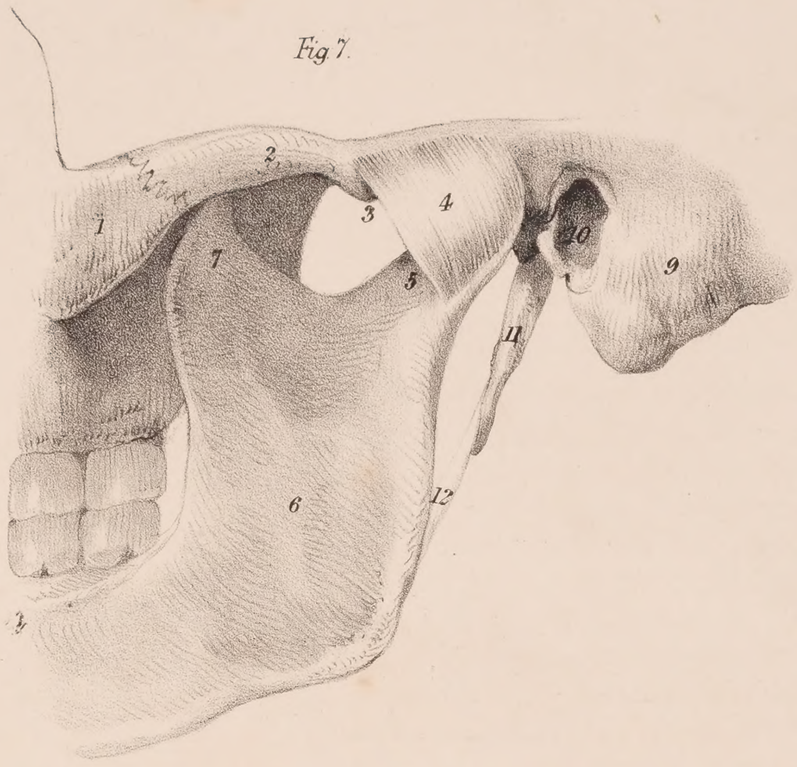


Fig. 2.

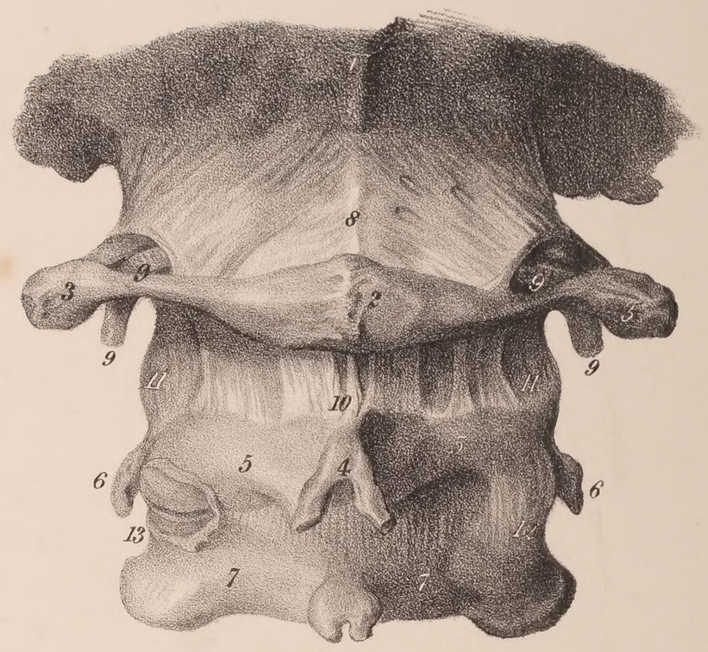


Fig. 4.

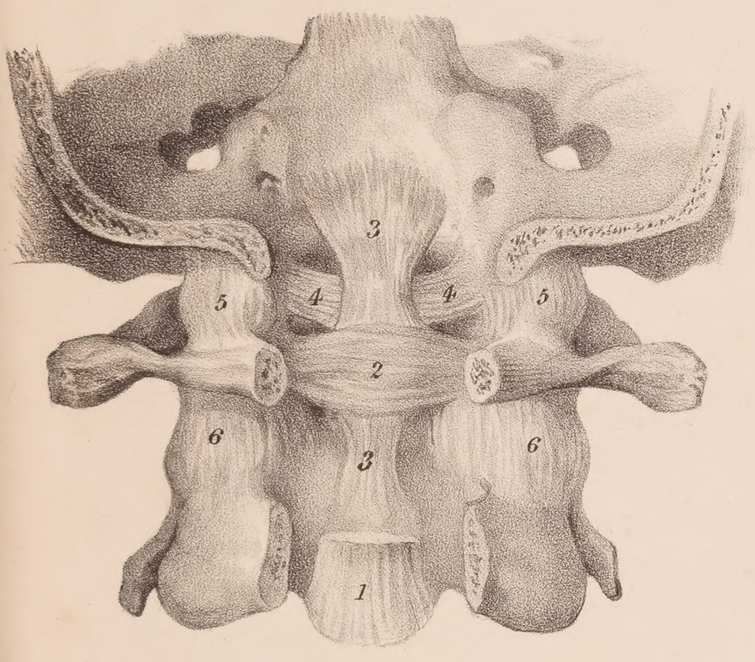


Fig. 8.

Fig. 3.

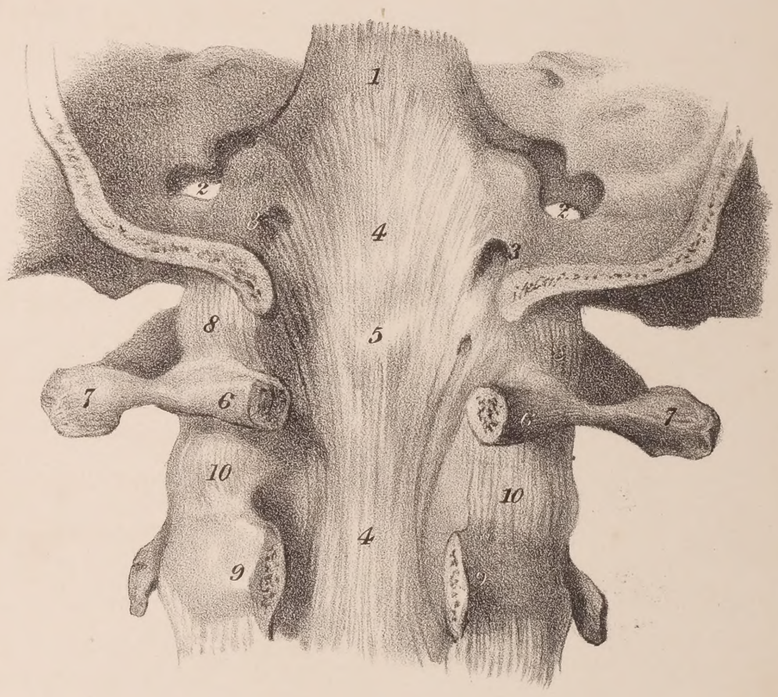


Fig. 5.

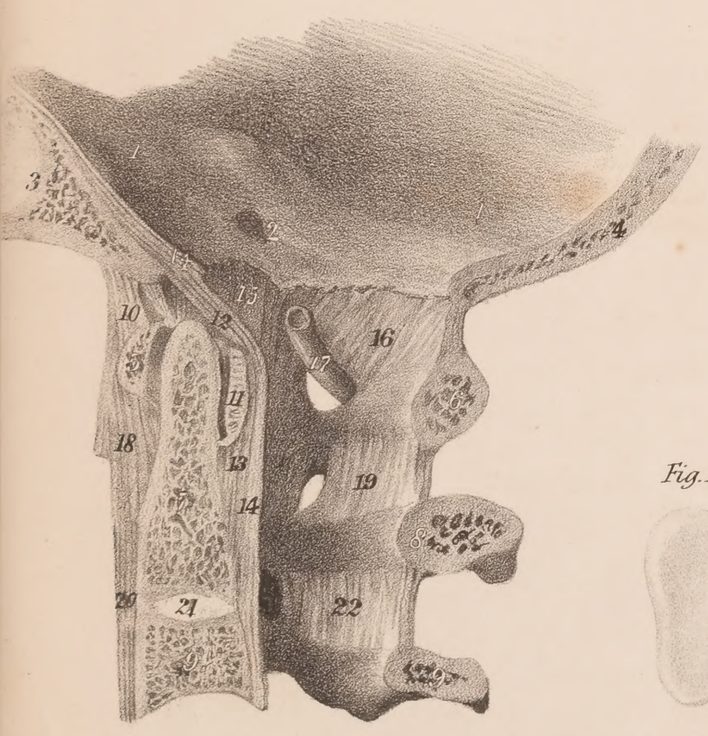
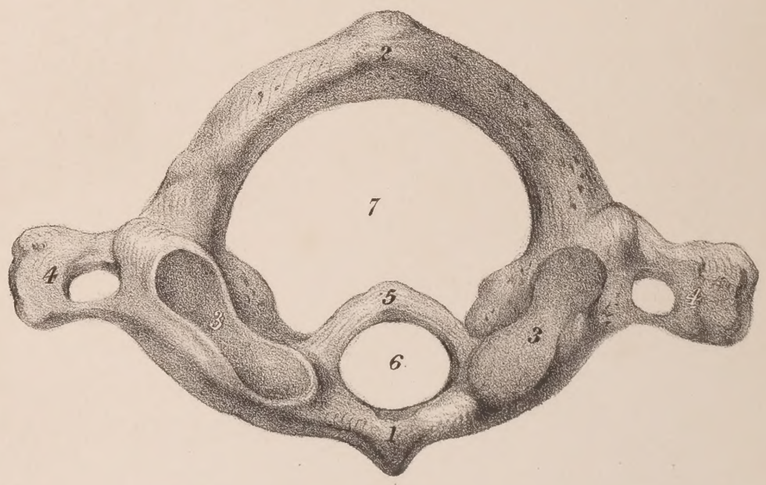


Fig. 10.

Fig. 9.

Fig. 11.

Fig. 6.



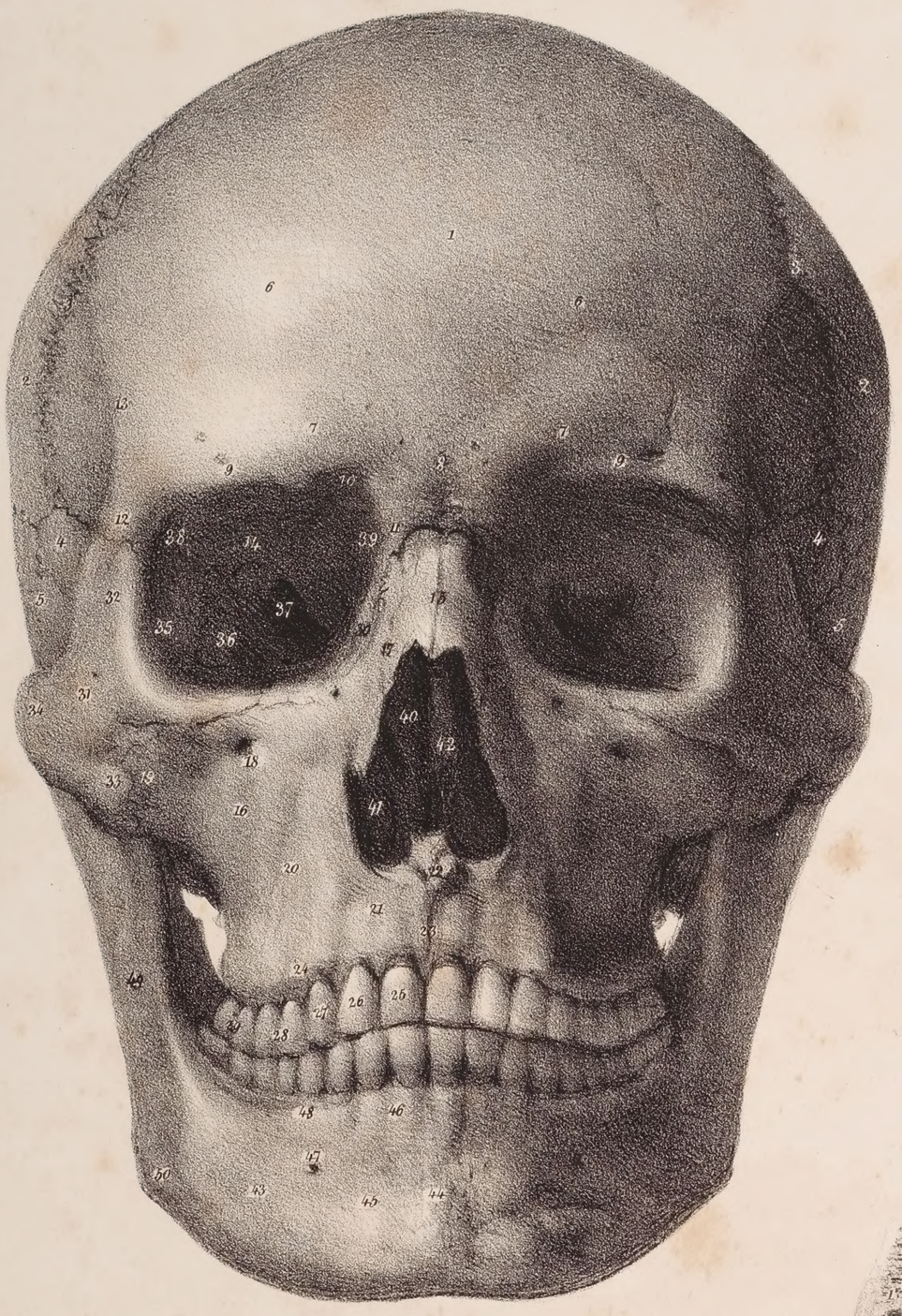
W. Fairland litho.

London, Taylor & Walton, Upper Gower St.

Printed by Fairland.

Plate 9.

Fig. 1.



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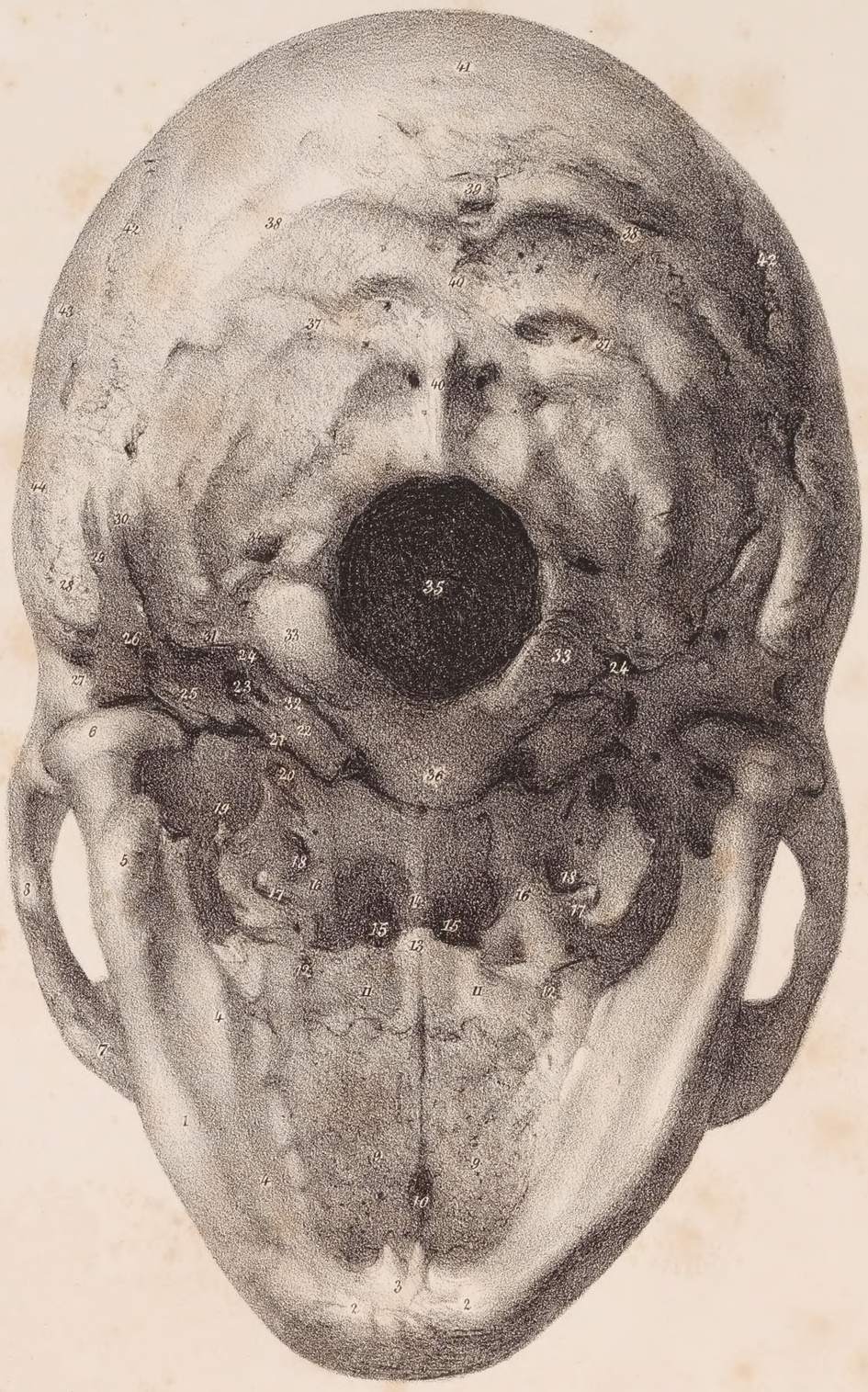

Fig. 5.

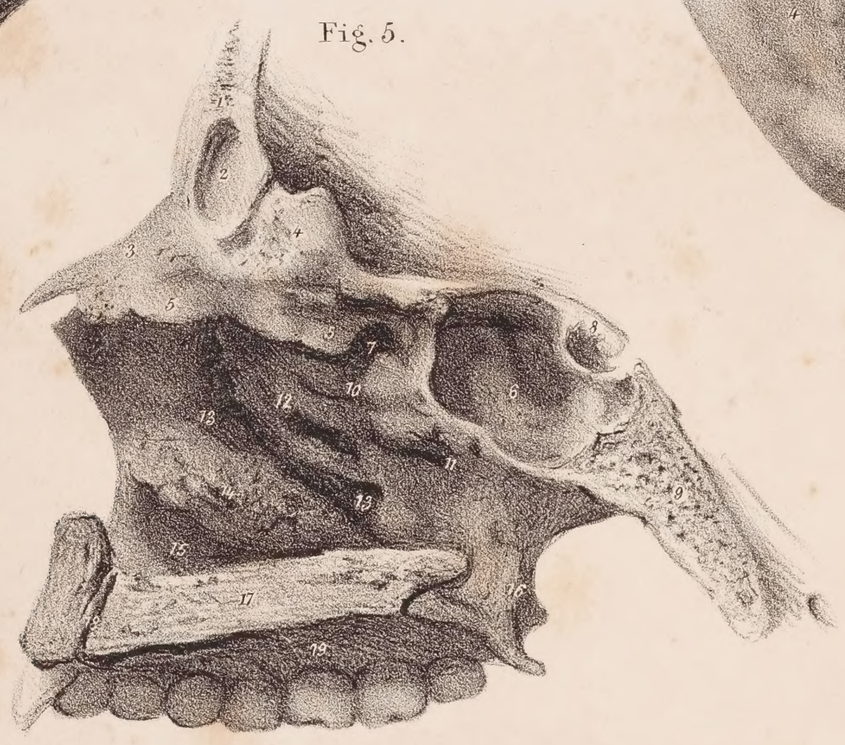

Fig. 2.

Fig. 4.

J. Walsh, del.

J. Graf, Printer to Her Majesty.

London. Taylor & Walton, Upper Gower Street.

Attachments of muscles.—The posterior third of the superior curved line gives attachment to the trapezius; its anterior two-thirds to the occipito-frontalis above, and to the sterno-mastoid below: the inner part of the space between the curved lines to the complexus: the external part to the splenius

PLATE IX.

In this plate several views of the cranium are exhibited.

Fig. 1. An anterior view of the cranium and face.

No. 1. The frontal bone. 2, 2. The parietal bone. 3, 3. The coronal suture uniting the frontal with the parietal bones. 4, 4. The upper part of the great ala of the sphenoid bone. 5, 5. The squamous portion of the temporal bone. 6, 6. The frontal eminence. 7, 7. The superciliary ridge. 8. The nasal tuberosity. 9, 9. The supra-orbital ridge. 10. The supra-orbital notch of the right orbit. 11. The internal angular process. 12. The external angular process. 13. The commencement of the temporal ridge.—The numbers 2, 4, and 5, are situated in the temporal fossa.—14. The orbital plate of the frontal bone. 15. The nasal bones. 16. The superior maxillary bone. 17. Its nasal process. 18. The infra-orbital foramen. 19. Its malar process. 20. The canine fossa. 21. The incisive fossa. 22. The nasal spine. 23. The harmonia suture uniting the two superior maxillary bones. 24. The alveolar process. 25. Median incisor tooth. 26. Lateral incisor. 27. Canine tooth. 28. The two bicuspides or small molars. 29. The great molars. 30. The lachrymal bone. 31. The malar bone. 32. Its frontal process. 33. Its maxillary process. 34. Its zygomatic process. 35. Its orbital process. 36. The orbital surface of the great ala of the sphenoid. 37. The sphenoidal fissure of the orbit. 38. The depression on the orbital plate of the frontal bone beneath its external angular process for the lachrymal gland. 39. The depression beneath the internal angular process, for the pulley of the trochlearis muscle. 40. The middle turbinated bone. 41. The inferior turbinated bone. 42. The vomer. 43. The body of the lower jaw. 44. Its symphysis. 45. The depression by the side of the symphysis for the origin of the depressor labii inferioris muscle. 46. The incisive fossa, for the levator labii inferioris. 47. The mental foramen. 48. The alveolar process; the teeth are the same as in the upper jaw. 49. The ramus of the lower jaw. 50. The angle of the lower jaw.

Fig. 2. A side view of the cranium and face.

The numbers of reference, from 1 to 50, are the same as in the preceding figure. No. 51. The sagittal suture, connecting the two parietal bones. 52. The temporal ridge upon the parietal bone. 53. The anterior inferior angle of the parietal bone. 54. The posterior inferior angle. 55. The squamous suture. 56. The zygoma. 57. Its tubercle. 58. Its superior root, continuous with the temporal ridge. 59. The meatus auditorius externus. 60. The mastoid process. 61. The styloid process. 62. The occipital bone. 63. The lambdoidal suture. 64. The additamentum suturæ lambdoidalis. 65. The additamentum suturæ squamosæ. 66. Condyle of the lower jaw. 67. Coronoid process of the lower jaw. 68. Semilunar notch of the lower jaw.

Fig. 3. Base of the skull.

Nos. 1, 1. The body of the lower jaw. 2, 2. The depressions near the symphysis, for the attachment of the digastric muscles. 3. Tubercles for the attachment of the genio-hyoid and genio-hyo-glossi muscles. 4, 4. The molar ridge of the lower jaw, seen upon one side. 5. The angle. 6. The condyle. 7. Part of the malar bone. 8. The zygomatic arch. 9, 9. The palatal processes of the superior maxillary bones. 10. The naso-palatine foramen. 11, 11. The palatal processes of the palate bones. 12, 12. The posterior palatine foramina. 13. The palate spine. 14. The vomer. 15, 15. The posterior nares. 16, 16. The internal pterygoid plates of the sphenoid bone. 17, 17. The hamular processes. 18, 18. The external pterygoid plates; the figures are placed in the pterygoid fossæ. 19. The zygomatic fossa of one side. 20. The foramen ovale. 21. The foramen lacerum basis cranii. 22. The petrous portion of the temporal bone. 23. The carotid foramen. 24, 24. The foramen lacerum posterius. 25. The vaginal process. 26. The stylo-mastoid foramen. 27. The meatus auditorius externus. 28. The mastoid process. 29. The digastric fossa. 30. Part of the additamentum suturæ lambdoidalis. 31. The transverse process of the occipital bone. 32. The anterior condyloid foramen. 33, 33. The condyles of the occipital bone. 34. The posterior condyloid foramen. 35. The foramen magnum. 36. The basilar process of the occipital bone. 37, 37. The inferior curved line of the occipital bone. 38, 38. The superior curved line. 39. The occipital tuberosity. 40, 40. The occipital spine. 41. The occipital bone. 42, 42. Part of the lambdoidal suture. 43. The parietal bone. 44. Mastoid portion of the temporal bone.

Fig. 4. Vertical and longitudinal section of the cranium.

No. 1. The frontal bone. 2. The frontal sinus. 3. Nasal bone. 4. Crista galli. 5. Central lamella of the ethmoid bone. 6. Vomer. 7. The inferior turbinated bone. 8. The palate. 9. The naso-palatine canal. 10. Pterygoid process. 11. Section of the basilar process of the occipital bone. 12. Sphenoidal cells. 13. Anterior clinoid process. 14. Roof of the right orbit. 15, 15. Grooves for the lodgment of the branches of the arteria meningea media. 16. Parietal bone, divided through the sagittal suture. 17. The occipital bone. 18. Border of the foramen magnum. 19. Petrous portion of the temporal bone. 20. The meatus auditorius internus. 21. Foramen lacerum posterius or jugular foramen. 22. The groove for the lateral sinus. 23. The mastoid process.

Fig. 5. A section showing the right nasal fossa.

No. 1. Part of the frontal bone. 2. Frontal sinus. 3. Nasal bone. 4. Crista galli. 5, 5. The upper part of the central lamella of the ethmoid. 6. Sphenoid cells. 7. Opening of the sphenoid cells into the superior meatus of the nose. 8. Anterior clinoid process. 9. Basilar process of the occipital bone. 10. Superior meatus of the nares. 11. The spheno-palatine foramen. 12. The middle turbinated bone. 13, 13. The middle meatus of the nasal fossa. 14. The inferior turbinated bone. 15. The inferior meatus. 16. The pterygoid process. 17. The cut edge of the palate. 18. The naso-palatine canal. 19. The under surface of the palate.

capitis: the space between the lower ridge and the great foramen to the recti majores and minores, and more outwardly to the obliquus superior: the under surface of the jugal eminences to the recti laterales: the fossæ at the inferior surface of the basilar process to the recti antici (majores and minores), and still more anteriorly to the superior constrictor of the pharynx.

Developement.—In the fœtus at birth this bone consists of four distinct pieces, of which one represents the basilar process, two the lateral or condyloid portions, and one the posterior or expanded part. Hence it is usually said to commence by four points of ossification. Meckel, however, is of opinion that it has no fewer than eleven separate centres, eight of them being in the broad (squamous) part. This doubtless has existed in some specimens which he examined; but ordinarily in the early stages of the developement there are found two ossific points in the lateral parts as above stated, one in the anterior or basilar, and four in the posterior broad part.

The Parietal Bones.—The parietal bones (ossa parietalia) form a principal part of the roof of the skull; they are of a square form, convex externally, concave internally, and present each two surfaces and four borders. The external surface rises towards its middle, where it presents a slight elevation, called the *parietal eminence*, below which is a curved line, forming part of the temporal ridge, and bounding a flat surface, which forms a part of the temporal fossa. At the upper and back part of the bone, usually about two lines from the sagittal suture, is a small hole, (foramen parietale,) which transmits a communicating vein; its position is exceedingly variable; even its existence is not constant.

The internal surface of the bone is marked by branching lines, corresponding with the course of the middle meningeal artery, and by depressions for the convolutions of the brain. Towards its middle is a depression, "parietal fossa," corresponding with the eminence (parietal) on the outside. Along the superior border is a slight depression, which, with a similar one in the corresponding bone, forms a groove adapted to the course of the longitudinal sinus; and in the same situation (in most skulls, particularly those of old persons) are some small pits corresponding with the so-named glandulæ Pacchioni.

The superior border is straight, and articulated with its fellow by a series of dentations; the inferior border, concave and bevelled off at its outer margin, is overlapped by the squamous portion of the temporal bone; the anterior unites with the frontal bone, and the posterior with the occipital.

The anterior inferior angle dips down to the great wing of the sphenoid bone, and presents a groove internally for the middle meningeal artery: the posterior inferior angle articulates with the mastoid part of the temporal bone, and presents internally a small part of the groove which lodges the lateral sinus.

Each parietal bone gives attachment to the temporal muscle by that part of its surface which lies beneath the temporal ridge: the remainder of its outer surface is covered by the aponeurosis of the occipito-frontalis.

Articulations.—It articulates with its fellow of the opposite side, and with the frontal, the sphenoid, the temporal, and the occipital bones.

Developement.—Its growth proceeds from one ossific centre which corresponds with the parietal eminence. At birth the antero-superior angles of these bones are not developed; hence there exists an interstice between them and the still divided os frontis, which is called the "fontanelle" (fons, bregma).

The Frontal Bone.—The frontal bone, (os frontis, coronale,) situated at the anterior part of the skull, and upper part of the face, is divisible into two parts (frontal and orbital), differing in size and position; of these, one extends upwards towards the vertex, forming three fourths of the extent of the bone; the other, inferior and horizontal in its direction, forms the roof of the orbits. To place the bone in its natural position, hold it so that the orbital plates shall look downwards, and the smooth convex surface forwards.

The external surface of the frontal part is smooth, and presents on each side a slight elevation, named *frontal eminence*, which corresponds with the most prominent part of the forehead: beneath this is an arched depression, bounded below by a prominent curved line, called the *superciliary ridge*, or arch, which is more or less prominent in different individuals. Immediately beneath this is the margin of the orbit (*orbital arch*), which is better defined towards its outer part, where it curves down to the malar bone, and forms the external angular process, than at its inner portion, where it gradually subsides towards the root of the nose. Towards the inner third of the orbital arch is a small foramen (*supra-orbital*), or sometimes a notch crossed by a ligament, which transmits the supra-orbital nerve and artery.

Between the superciliary ridges is the *nasal eminence*, or glabella, which is prominent in propor-

tion to the size of the frontal sinuses; it is bounded inferiorly by a rough surface which articulates with the nasal bones and the ascending processes of the superior maxilla. From this surface projects downwards in the median line a flat thin process, called the *nasal spine;* it articulates in front with the nasal bones, and behind with the perpendicular lamella of the ethmoid.

The internal surface of this part of the bone is concave, and presents along the median line a groove corresponding with the longitudinal sinus. The margins of the groove gradually approach towards the forepart of the bone, and in some cases unite so as to form a ridge; but in others the groove, narrowed almost to a line, continues apparent down to the foramen cæcum. In either case it gives attachment to the falx; this ridge terminates in a minute foramen, called *foramen cæcum,* from its having been supposed to be merely a cul-de-sac, but it is in reality pervious, and lodges a small spur-like process of the dura mater, and transmits a vein which enters the sinus from the nasal fossæ.

The orbital plates or processes are smooth and concave at their inferior surface; the superior or cerebral is convex, and marked more or less in different instances by elevations and depressions corresponding with the sulci and convolutions of the anterior lobes of the brain which rest upon them. They are separated by a deep excavation (incisura ethmoidalis), which receives within it the cribriform plate of the ethmoid bone, and round its margins are several cells which complete the cavities lodged within the lateral parts of the last-named bone. In this margin may also be observed two foramina, (*anterior* and *posterior orbital,*) which are common to the frontal and ethmoid bones, as their contiguous margins contribute to their formation. The anterior one transmits the nasal twig of the ophthalmic nerve, and the anterior ethmoidal artery; the other, the posterior ethmoidal artery and vein. Each orbital plate is bounded externally by a thick well-marked prominence, called the *external angular process;* and internally by a depressed and smooth one (*internal angular process*). Near the inner one is a slight depression, to which is attached the cartilaginous pulley of the trochlearis muscle; near the outer and within the orbit, is a depression for the lodgment of the lachrymal gland; the external side of this process is slightly hollowed, and forms part of the temporal fossa.

The thickness of the frontal bone varies considerably in different parts of it. The orbital plates are thin and translucent; the nasal and external angular processes are thick and prominent. The upper or broad part is thinner at the frontal eminences than elsewhere, if these are well-marked, so as to indicate a full developement of the corresponding cerebral parts. In childhood the two tables are separated only by the diploë, as in other bones; but, in adult age, an interval exists between them at the middle line over the nasal process, and extending outwards for some way under the superciliary ridges. This interval, the extent of which varies in different individuals, is divided by a ridge of bone into two parts or cavities called the *frontal sinuses;* they are lined by mucous membrane, and communicate with the anterior ethmoidal cells.

Articulations.—The frontal articulates with twelve bones; superiorly with the two parietal, laterally and behind with the sphenoid, inferiorly with the ethmoid; with the nasal bones by the nasal spine; with the ossa unguis; with the ascending process of the superior maxillary bones; and with the malar bones. The mode of articulation differs in different parts of its circumference. Thus, the superior border is found to overlap and rest on the parietal bones, whilst towards the lateral and inferior parts the exterior table of the bone is bevelled off, and is covered in by the parietal. The posterior border of the orbital plates, straight and squamous, is in a manner inserted between the margins of the two alæ of the sphenoid bone, with each of which it articulates.

PLATE X.

This plate exhibits the occipital and parietal bones, with the interior of the base of the skull.

Fig. 1. The external surface of the occipital bone.

No. 1. The protuberance of the occipital bone. 2, 2. Its spine. 3, 3. The superior curved line. 4, 4. The surface above the superior curved line to which the occipito-frontales muscles are attached. 5, 5. The inferior curved line. 6, 6. The rough surface to which the complexi muscles are attached. 7, 7. The rough surface to which the splenii capitis are attached. 8, 8. The rough surface for the recti postici and obliqui superiores. 9. The foramen magnum. 10, 10. The condyles of the occipital bone. 11, 11. The rough surface within the condyles, to which the odontoid ligaments are attached. 12, 12. The inner openings of the anterior condyloid foramina. 13. The basilar process, its under surface. 14. Its upper and concave surface, upon which the medulla oblongata rests. 15, 15. The posterior condyloid foramina. 16, 16. The transverse processes of the occipital bone. 17, 17. The superior borders of the bone. 18, 18. Its inferior borders. 19, 19. The notches corresponding with the jugular foramina.

Fig. 2. The internal surface of the occipital bone; after Cheselden.

Nos. 1, 1. The cerebral fossæ, for lodging the posterior lobes of the cerebrum. 2, 2. The cerebellar fossæ, fo

Attachment of muscles.—It gives attachment to the corrugator supercilii—to a small part of the temporal and of the orbicularis palpebrarum.

Developement.—This bone begins by two osseous points corresponding with the frontal eminences. The lateral pieces formed by the spreading of the ossification ultimately become united along the

the lateral lobes of the cerebellum. 3. The superior arm of the crucial ridge: this ridge is grooved for the superior longitudinal sinus, and to the borders of the groove the falx cerebri is attached. 4. The inferior arm of the crucial ridge, for the falx cerebelli and cerebellar sinuses. 5, 5. The transverse ridge, for the tentorium cerebelli and lateral sinuses. 6. The internal occipital protuberance. 7, 7. The superior borders of the bone. 8, 8. Its inferior borders. 9, 9. The jugular eminences. 10. The jugular fossa of the right side. 11. The border of the bone which articulates with the petrous portion of the temporal bone. 12. The anterior condyloid foramen of the right side. 13, 13. The condyles. 14. The anterior margin of the foramen magnum. 15. The under surface of the basilar process. 16. Its lateral surface. 17. The surface which articulates with the sphenoid bone.

Fig. 3. The external surface of the right parietal bone.

No. 1. The parietal eminence. 2, 2. The temporal ridge. 3, 3. The rough surface above the ridge, upon which the aponeurosis of the occipito-frontalis muscle rests. 4, 4. The smooth surface below the ridge, that gives attachment to the temporal muscle. 5. The superior or sagittal border of the bone. 6. The parietal foramen. 7. The anterior and concave border of the parietal bone. 8. The posterior and somewhat convex border. 9. The inferior or squamous border. 10, 10. The grooves upon this part of the bone correspond with ridges upon the squamous border of the temporal. 11. The anterior and inferior angle of the bone. 12. The posterior and inferior angle.

Fig. 4. The left parietal bone seen upon its internal surface; after Cheselden.

Nos. 1, 1. The grooves for lodging the ramifications of the arteria meningea media. 2. At the anterior and inferior angle of the bone, the groove for the main trunk of this artery is converted into a canal. 3. A groove upon the posterior and inferior angle for the lodgment of the lateral sinus. 4, 4. A partial groove, completed by the articulation of the two parietal bones, and serving for the lodgment of the superior longitudinal sinus. 5. The superior or sagittal border of the bone. 6. The anterior or coronal border; the formation of the serrations at the expense of the outer table is well exhibited. 7. The posterior or lambdoidal border. 8. The inferior or squamous border.

Fig. 5. A view of the interior of the base of the skull; the calvarium having been removed.

Nos. 1, 1. The cut surface of the frontal bone; in this section, the structure of the cranial bones, consisting of two tables and an intervening cellular part, the diploë is well seen. 2, 2. The parietal bone. 3, 3. The squamous part of the temporal bone; in this bone the diploë is not present. 4, 4. The occipital bone. 5. A part of the ridge on the internal surface of the frontal bone, which gives attachment to the falx cerebri, and supports the commencement of the longitudinal sinus. 6. The foramen cæcum. 7. The crista galli process of the ethmoid bone. 8, 8. The cribriform plates with their foramina. 9, 9. The orbital plates of the frontal bone; the depressions on these plates are the digital fossæ. 10. The ethmoidal spine of the sphenoid bone. 11, 11. The lesser wings of the sphenoid. 12, 12. The optic foramina. 13, 13. The anterior clinoid processes. 14. The processus olivaris.—The whole of the preceding figures, from No. 4, are situated in the anterior fossa of the base of the cranium. Nos. 15, 15, with 13, 13, and 14, form the posterior boundary of this fossa, and the anterior boundary of the middle fossa of the base of the cranium. The border, 15, 15, is received into the fissure of Sylvius on each side of the base of the brain.—16. The sella Turcica. 17, 17. The depression upon each side of the sella Turcica, which lodges the last turn of the internal carotid artery. 18, 18. The depression upon each side of the sella Turcica, which supports the internal carotid artery and the cavernous sinuses. 19, 19. The foramen rotundum of the sphenoid bone. 20, 20. The foramen ovale. 21, 21. The foramen spinosum. 22, 22. The foramen lacerum basis cranii. 23, 23. The cerebral surface of the greater ala of the sphenoid bone. 24, 24. The internal surface of the squamous portion of the temporal bone. 25, 25. The anterior surface of the petrous portion of the temporal bone. 26, 26. The eminence upon the anterior surface of the petrous portion of the temporal bone, which marks the situation of the superior or perpendicular semicircular canal. 27, 27. The groove which leads to the hiatus Fallopii.—The whole of the preceding figures, from No. 16, are situated in the middle fossa of the base of the cranium.—28, 28. The superior border of the petrous portion of the temporal bone, for the attachment of the tentorium cerebelli. 29, 29. The notch near the extremity of the petrous portion of the temporal bone, which supports the fifth nerve. 30, 30. The posterior clinoid processes.—The figures 28, 29, and 30, at each side, mark the posterior boundary of the middle fossa of the base of the cranium and the anterior boundary of the posterior fossa.—31. The basilar portion of the sphenoid and occipital bones, rendered concave for the support of the pons Varolii and medulla oblongata. 32, 32. The posterior surface of the petrous portion of the temporal bone. 33, 33. The meatus auditorius internus. 34. The aqueductus vestibuli on the right petrous bone. 35, 35. The groove for the inferior petrosal sinus. 36, 36. The jugular fossa. 37. A part of the jugular foramen of the right side. 38, 38. The groove for the lateral sinus, on the occipital bone. 39, 39. The same groove on the mastoid portion of the temporal bone. 40, 40. The same groove upon the posterior and inferior angle of the parietal bone. 41, 41. The groove upon the occipital portion of the occipital bone. 42. The internal occipital protuberance. 43. The inferior arm of the crucial ridge of the occipital bone. 44, 44. Cerebellar fossæ. 45. The foramen magnum. 46, 46. The anterior condyloid foramen.—The whole of the preceding figures from No. 31. are situated in the posterior fossa of the base of the cranium; the numbers 40, 41, and 42, forming its posterior boundary.—47. The superior arm of the crucial ridge of the occipital bone. 48. The cerebral fossa of the right side of the occipital bone. 49. The arch of the zygoma.

Plate 10.

Fig 3.

Fig 1.

Fig 5.

Fig 2.

Fig 4.

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Plate II.

Fig. 1.

Fig. 2.

Fig. 9.

Fig. 11.

Fig. 4.

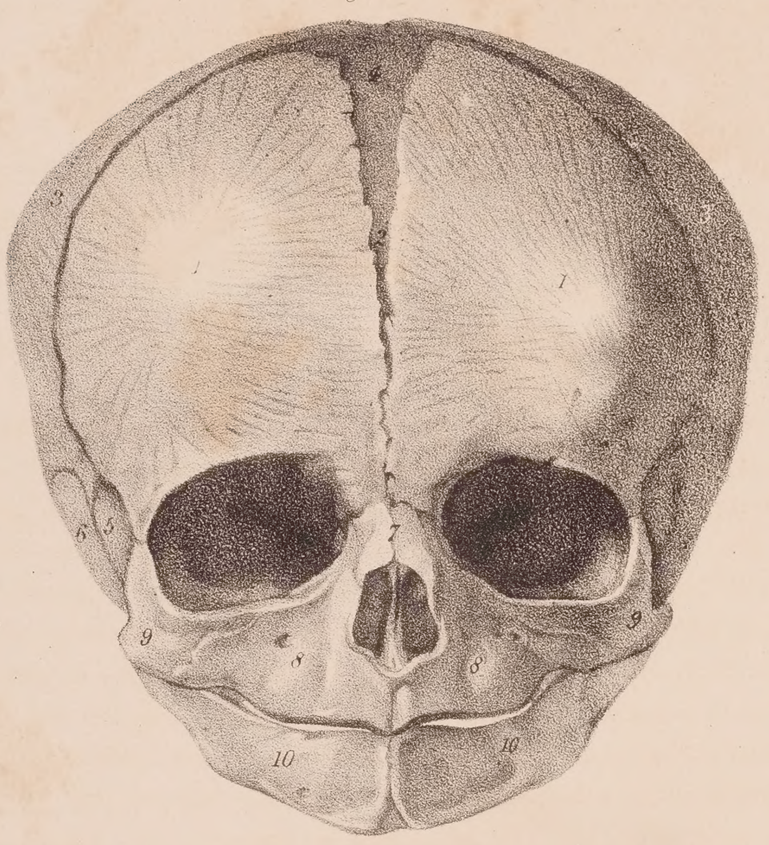

Fig. 8.

Fig. 10.

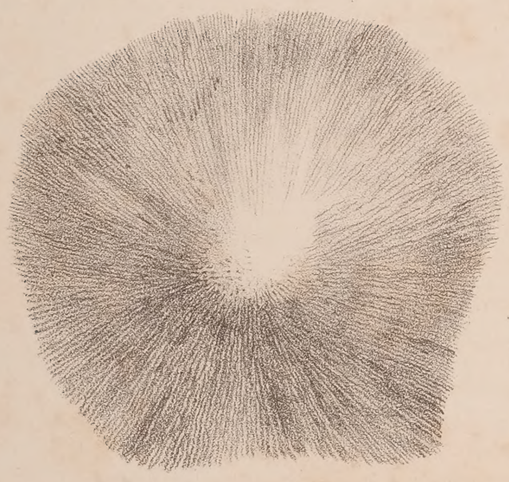

Fig. 6.

Fig. 7.

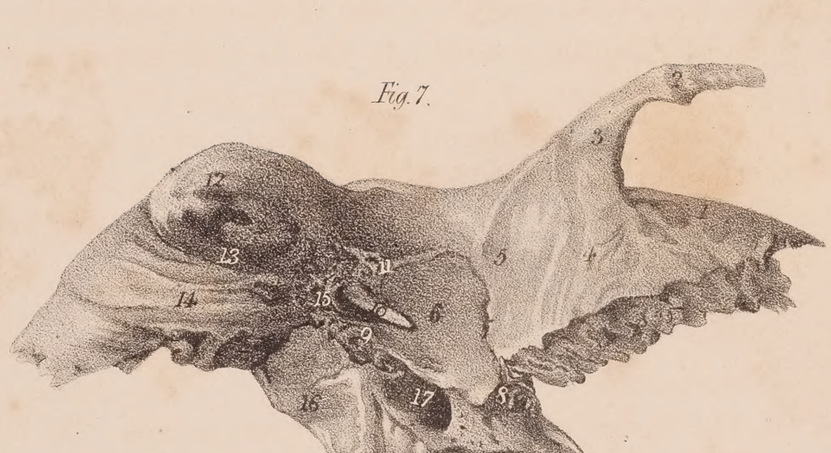

Fig. 5.

Fig. 3.

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middle by a straight suture, which runs from the vertex, where it is continuous with the sagittal suture, down to the nose. It is generally obliterated at an early period.

The Temporal Bone.—The temporal bones, two in number, are so named because they occupy

PLATE XI.

The frontal and temporal bones in the adult and in the fœtus.

Fig. 1. The frontal bone seen upon its anterior aspect: after Bourgery.

Nos. 1, 1. The frontal eminences. 2, 2. The superciliary ridges. 3. The nasal eminence or tuberosity. 4, 4. The supra-orbital ridges. 5, 5. The supra-orbital notches. 6. The internal angular process of one side. 7. The rough surface for articulation with the nasal bones. 8. The nasal spine. 9. The external angular process. 10. The temporal ridge. 11. A part of the temporal fossa. 12, 12. The border which articulates with the parietal bones.

Fig. 2. The frontal bone seen upon its internal aspect: after Cheselden.

No. 1. The longitudinal ridge which gives attachment to the falx cerebri. The dark line in the course of this ridge indicates the existence of a median suture in this bone. 2. Depressions for glandulæ Pacchioni. 3. The nasal spine. 4, 4. The borders of the ethmoidal fissure. 5, 5. The openings into the frontal sinuses. 6, 6. The orbital plates. 7, 7. The supra-orbital ridges. 8. The internal angular process of one side. 9. The external angular process. 10. A part of the temporal fossa. 11, 11. The border which articulates with the lesser wing of the sphenoid. 12, 12. The border which articulates with the greater wing of the sphenoid. 13, 13. The border which articulates with the parietal bones.

Fig. 3. The frontal bone seen upon its inferior or orbito-nasal aspect: after Cheselden.

Nos. 1, 1. The frontal portion of the bone. 2. A line indicating the existence of a frontal suture. 3. The nasal eminence or tuberosity. 4. The rough surface which articulates with the nasal bones, and the nasal spine. 5. The ethmoidal fissure. 6, 6. The borders of the ethmoidal fissure. 7, 7. The orbital plates. 8, 8. The supra-orbital ridges. 9. The internal angular process of one side. 10. The depression for lodging the cartilaginous pulley of the trochlearis muscle. 11. Two supra-orbital foramina. 12. The external angular process. 13. The lachrymal fossa. 14. The temporal ridge. 15. Part of the temporal fossa. 16, 16. The border which articulates with the sphenoid bone.

Fig. 4. An anterior view of the fœtal skull, showing the mode of developement of the frontal bone by two lateral portions.

Nos. 1, 1. The lateral portions of the frontal bone. 2. The line of approximation of the two lateral portions; when union is incomplete in the adult, a frontal suture is met with in this situation. 3, 3. The parietal bones. 4. The anterior fontanelle. 5. The extremity of the great ala of the sphenoid of one side. 6. The temporal bone of the same side. 7. The nasal bones. 8, 8. The superior maxillary bones. 9, 9. The malar bones. 10, 10. The inferior maxillary bone consisting of two lateral portions.

Fig. 5. The temporal bone of the right side, viewed upon its external surface: after Bourgery.

No. 1. The squamous portion. 2. The zygoma. 3. The tubercle of the zygoma. 4. The superior root of the zygoma, which serves to mark the separation of the squamous from the mastoid portion of the temporal bone. 5. The middle root of the zygoma. 6. The eminentia articularis, with which the anterior root is continuous. 7. The mastoid portion of the temporal bone. 8. The mastoid process. 9. The mastoid foramen. 10. The meatus auditorius externus. 11. The processus auditorius. 12. The styloid process. 13. The vaginal process. 14. The glenoid fossa.

Fig. 6. The temporal bone of the right side, seen upon its internal aspect: after Cheselden.

No. 1. The squamous portion. 2. A groove for the posterior branch of the arteria meningea media. 3, 3. The squamous border, which articulates with the lower border of the parietal bone. 4. The extremity of the zygoma seen projecting beyond the anterior border of the temporal bone. 5. The mastoid portion of the bone. 6, 6. The groove for the lateral sinus. 7. The internal termination of the mastoid foramen. 8. The petrous portion of the temporal bone. 9. The meatus auditorius internus. 10. A small notch for the insertion of a process of dura mater. 11. The opening of the aquæductus vestibuli. 12. Groove for the superior petrosal sinus. 13. The elevation corresponding with the superior semicircular canal. 14. Groove for the inferior petrosal sinus. 15. The irregular notch which forms the anterior boundary of the jugular foramen. 16. The extremity of the styloid process.

Fig. 7. The inferior or basial surface of the right temporal bone.

No. 1. The squamous portion. 2. The zygoma. 3. Its tubercle. 4. The eminentia articularis. 5. The glenoid fossa; its condyloid portion. 6. Its parotid portion. 7. The glenoid fissure. 8. The opening for the Eustachian tube. 9. The vaginal process. 10. The styloid process. 11. The lower border of the processus auditorius. 12. The mastoid process. 13. The digastric fossa. 14. The occipital groove. 15. The stylo-mastoid foramen. 16. The jugular fossa. 17. The carotid foramen. 18. The petrous portion of the temporal bone.

Fig. 8. The left temporal bone of the fœtus, showing three of the pieces of which it consists at an early period.

No. 1. The squamous portion. 2. The mastoid portion. 3. The auditory portion.

Fig. 9. The petrous portion of the temporal bone of a fœtus: after Cheselden.

Fig. 10. The parietal bone of a fœtus, showing the radiated disposition of the osseous fibres of which it is composed at this early period: after Cheselden.

Fig. 11. The occipital bone of a fœtus, showing the four pieces of which it consists at an early period: after Cheselden.

No. 1. The occipital portion. 2, 2. The condyloid portions. 3. The basilar portion.

that part of the head on which the hair first becomes white, and thus indicates the ravages of time (*ossa temporis*).

The *temporal* bone (os temporis) is placed at the side and basis of the skull. When viewed in its natural position, it presents two portions, one at the side of the skull, towards its middle and lower part, which is flat and vertical in its direction; whilst the other is horizontal and projects inwards so as to be wedged between the occipital and sphenoid bones. But to facilitate its description, it may be divided into three parts, adopting the division which obtains in infancy before the ossification is complete. One is superior, flat, scale-like, and named the squamous portion (squama, a scale); another posterior, thick at its base, but tapering downward like a nipple, the mastoid part; the third, called petrous from its hardness, is internal and intermediate, projecting into the basis of the skull.

The *squamous* portion, (pars squamosa,) by its external surface which is smooth, forms part of the temporal fossa, and is bounded above by an arched border, below by a horizontal process called "zygoma." The inner surface of the squamous part of the bone, slightly concave in its general outline, is marked by cerebral impressions like the other bones of the head, and by slight linear grooves for the branches of the middle meningeal artery. Its upper edge is bevelled off so as to form a thin scale which overlies the parietal bone.

The *zygoma*, or zygomatic process, (ζευγνυμι, to connect or yoke together,) forms a yoke connecting the temporal with the malar bone, and under which the temporal muscle passes; it is broad posteriorly at its base, where it projects outward from the squamous part of the bone, but soon narrows, and turns forward; its outer surface is convex and subcutaneous, the inner surface is concave and bounds the temporal fossa; the superior margin, very thin, gives attachment to the temporal fascia; the inferior one is thicker and shorter, owing to the end of the process being bevelled off so as to rest on the malar bone, with which it articulates. At its base the upper surface is concave, and supports the posterior border of the temporal muscle. The under surface forms the border of the glenoid cavity; here it presents two roots, of which one runs horizontally backwards, forming the outer margin of the glenoid cavity, whilst the other turns inwards and forms the anterior border of that cavity. At the point of division is a slight tubercle, which gives attachment to the external lateral ligament of the lower jaw. Now the anterior root widens and subsides, becoming concave from without inwards and convex from before backwards, as it forms part of the articular surface upon which the lower jawbone moves; in its natural condition it is covered with cartilage. The other root, which is continued horizontally backwards, bifurcates, one part turning inwards to the fissura Glasseri, whilst the other gradually subsides as it passes backwards over the auditory tube, yet marks the separation between the squamous and mastoid portions of the bone. The *glenoid fossa* (γληνη, a shallow pit), marked off as here indicated, is elongated from without inwards, and divided into two parts by a fissure, (*fissura Glasseri,*) which transmits the chorda tympani nerve, laxator tympani muscle, and gives attachment to the processus gracilis of the malleus. The part before the fissure is smooth, and articulates with the lower jaw; the remainder lodges a process of the parotid gland.

The *mastoid* part of the bone externally is rough, for the attachment of muscles, and prolonged downwards, forming the mastoid or nipple-shaped process (μαστος, a nipple; ειδος), from which this division of the bone is named. This process overhangs a groove, (*digastric fossa,*) for the attachment of the digastricus muscle; close to this is a slight groove, the occipital groove. When viewed at its inner surface, the mastoid part presents a broad and generally a deep groove, which curves forwards and downwards; it here supports part of the lateral sinus. It is usually pierced by a foramen (mastoideum), which opens into the sinus from the outer surface, commencing near the posterior border of the bone. The size and position of this hole vary in different instances; it sometimes exists at one side and not at the other.

The *petrous* part, pars petrosa, (πετρος, a stone,) forms a triangular pyramid (pyramis trigona) which projects into the base of the skull forwards and inwards; it presents a base, an apex (truncated), three surfaces, and three borders. In the base is situated the orifice of the auditory canal, which is bounded above by the posterior root of the zygoma; inferiorly, and in the greatest part of its circumference, by a curved uneven lamella (*auditory process*), to which the cartilage of the ear is attached: this process is in the fœtus a separate piece. The canal itself (*meatus auditorius externus*), narrower in the middle than at its extremities, is directed obliquely forwards and inwards, and leads into the tympanum. The apex or inner end of the pars petrosa, rough, irregular, and, as it were, truncated, forms part of the foramen lacerum medium, and is pierced by the termination of the carotid canal (canalis caroticus):—this canal commences in the inferior surface of the bone anterior and internal to

the jugular fossa, ascends at first perpendicularly, but soon turns horizontally forwards and inwards to the apex, where it ends.

The anterior surface of the petrous portion forms part of the middle fossa in the base of the skull, where it looks obliquely upwards and forwards. Towards the apex it is slightly grooved, where it corresponds with the ganglion of the fifth pair of nerves (Casserian). A narrow groove is seen to run obliquely backwards and outwards; it lodges a small nerve (the Vidian); it is named the *hiatus Fallopii*, and leads to the aqueduct of Fallopius. Farther back is a rounded eminence indicating the situation of the superior semi-circular canal. The *aqueduct* of Fallopius just alluded to commences at the internal auditory meatus; it is a small osseous tube lodged in the interior of the bone, and passing at first in an arched direction, outwards and upwards, then backwards and downwards towards the basis of the skull, where it ends in the stylo-mastoid foramen; it transmits the portio dura, and receives, through the hiatus Fallopii, the Vidian nerve. The posterior surface looks obliquely backwards, and forms part of the third or posterior fossa at the base of the skull. In it will be observed a large orifice, leading to a short canal (*meatus auditorius internus*). The canal is oblique in its direction, having an inclination outwards and forwards. It conveys the auditory and facial nerves. Its fundus is formed by a lamella of bone (*lamina cribrosa*), divided into two parts by a crest or ridge; the upper or smaller part is pierced by a foramen which transmits the facial nerve, whilst the lower presents several very small apertures through which the fibrillæ of the auditory nerve pass. About three lines further back than the orifice of the meatus is a narrow fissure, oblique in its direction. It is the termination of the aquæductus vestibuli. Between the aperture of the aqueduct and that of the meatus is an irregular depression, into which a small process of the dura mater is fixed.

On the inferior surface of the pars petrosa, which is exceedingly irregular, we observe, proceeding from within outwards and backwards, a rough surface, giving attachment to the levator palati and tensor tympani muscles, the carotid foramen, the jugular fossa, the vaginal and styloid processes; lastly, the stylo-mastoid foramen. The carotid foramen leads into the curved canal (canalis caroticus) already noticed. The *jugular fossa* (fossa bulbi venæ jugularis internæ) is named by some the "thimble-like" cavity, also the "foramen lacerum posterius." It is of large size, and formed in the contiguous margins of the temporal and occipital bones. It is in some cases divided into two parts, but unequally, by a spicula of bone; the anterior and inner portion gives passage to the glosso-pharyngeal, vagus, and spinal accessory nerves, whilst the posterior and larger one transmits the jugular vein. External to the margin of the fossa is the styloid or pencil-like process, long and tapering, with an inclination downwards and forwards. Its length varies from an inch to an inch and a half; it gives attachments to three muscles and two ligaments. Close before the base of the styloid process is a compressed bony plate, the free surface of which looks obliquely forwards and forms the back part of the glenoid or articular cavity. This is named the *vaginal* process (vagina processûs styloidei). Between the root of the styloid process and the mastoid is the *stylo-mastoid foramen*, (f. stylo-mastoideum,) so called from its position with regard to the processes just named. It forms the outlet or termination of the aqueduct of Fallopius, and gives exit to the facial nerve.

The superior border of the pars petrosa is grooved for the petrosal sinus; the anterior, which is very short, forms, with the squamous part, an angle at their point of junction, in which is situated the

PLATE XII.

Bones of the head and face.

Fig. 1. An anterior view of the sphenoid bone: after Cheselden.

No. 1. The ethmoidal spine. 2. The lesser wing of one side. 3. The sphenoidal spongy bone of one side closing the sphenoidal cells. 4. The sphenoidal cells exposed upon the opposite side. 5. The rostrum. 6. The sphenoidal fissure. 7. The orbital surface of the great ala of the sphenoid bone. 8. The temporal surface. 9. The pterygoid crest. 10. The zygomatic portion of the external surface of the great ala of the sphenoid. 11. The foramen rotundum. 12. The Vidian foramen. 13. The smooth surface upon the anterior surface of the root of the pterygoid process against which Meckel's ganglion rests. 14. The pterygo-palatine canal. 15. The internal pterygoid plate of the pterygoid process. 16. Its hamular process. 17. The external pterygoid plate. 18. The triangular notch between the pterygoid plates for the reception of the tuberosity of the palate bone. 19. The foramen ovale. 20. A notch, which in this bone would seem to represent the spinous foramen.

Fig. 2. The sphenoid bone seen upon its posterior aspect: after Cheselden.

No. 1. The basilar portion of the sphenoid bone. 2. The surface which articulates with the basilar process of the occipital bone. 3, 3. The posterior clinoid processes. 4, 4. The anterior clinoid processes. 5, 5. The lesser wings of the sphenoid. 6. The optic foramen on the right side. 7, 7. The sphenoidal fissure. 8.

orifice of the Eustachian tube, a canal which leads from the pharynx to the tympanum: above this, and separated from it by a thin horizontal lamella (*processus cochleariformis*), is another osseous tube, that gives passage to the tensor tympani muscle. The posterior border articulates with the basilar

The great ala of the sphenoid of one side; its cerebral surface. 9. The spinous process. 10. The posterior opening of the Vidian canal. 11. The pterygo-palatine canal. 12. The pterygoid fossa. 13. The internal pterygoid plate of the pterygoid process. 14. The hamular process. 15. The external pterygoid plate.

Fig. 3. The superior or cerebral surface of the sphenoid bone: after Cheselden.

No. 1. The ethmoidal spine. 2. The olivary process. 3, 3. The lesser wings. 4, 4. The anterior clinoid processes. 5, 5. The optic foramina. 6, 6. The depression for the last turn of the internal carotid artery. 7. The sella Turcica. 8, 8. The posterior clinoid processes. 9. The basilar portion of the bone. 10. The surface which articulates with the basilar process of the occipital bone. 11, 11. The groove upon the side of the body of the sphenoid bone for the horizontal portion of the internal carotid artery. 12. The sphenoidal fissure of one side. 13. The foramen rotundum. 14. The foramen ovale. 15. The foramen spinosum. 16. The spinous process of the sphenoid. 17. The spine at the extremity of the spinous process. 18. The great ala of the sphenoid; its cerebral surface. 19. The internal pterygoid plate of the pterygoid process. 20. The hamular process. 21. The external pterygoid plate.

Fig. 4. Cerebral surface of the sphenoid bone of a fœtus.

No. 1. The anterior portion of the body. 2, 2. The rudimentary lesser wings. 3. The posterior portion of the body. 4, 4. Rudimentary pterygoid processes. 5, 5. Rudimentary greater wings. 6, 6. Rudimentary spinous processes.

Fig. 5. The ethmoid bone, seen upon its upper and lateral surface: after Cheselden.

No. 1. The crista galli process. 2, 2. The cribriform plate. 3, 3. The superior borders of the bone. 4. The os planum. 5. The anterior cells, completed by the lachrymal bone. 6, 6. Posterior ethmoidal cells. 7. The anterior extremity of the central lamella.

Fig. 6. The ethmoid bone, seen upon its inferior and lateral surface: after Cheselden.

Nos. 1, 1. The central perpendicular lamella. 2. The os planum. 3. The superior turbinated bone. 4. The middle turbinated bone. 5. The superior meatus of the nose.

Fig. 7. The ethmoid bone, seen upon its posterior surface.

No. 1. The crista galli. 2, 2. The cribriform plates. 3, 3. The upper borders of the bone. 4, 4. The os planum. 5, 5. The lateral masses. 6. The central lamella. 7, 7. The superior turbinated bones. 8, 8. The middle turbinated bones. 9, 9. The superior meatuses.

Fig. 8. The two nasal bones, articulated and seen upon their under surface: after Cheselden.

No. 1. The upper thick extremity of the bones. 2, 2. The irregular free margin. 3. 3. The lateral borders which articulate with the superior maxillary bones. 4, 4. The groove upon the under surface of each nasal bone, for the external branch of the nasal nerve.

Fig. 9. The lachrymal bone; its external surface: after Cheselden.

No. 1. The crest which divides the bone into two portions. 2. The orbital portion. 3. The lachrymal portion, grooved for the reception of the lachrymal sac.

Fig. 10. The lachrymal bone; its internal surface: after Cheselden.

No. 1. A part of the vertical crest of the external surface.

Fig. 11. The inferior turbinated bone, seen upon its convex surface.

Fig. 12. The malar bone of the right side, seen upon its external surface.

No. 1. The frontal process. 2. The superior maxillary process. 3. The zygomatic process. 4. One of the foramina for the transmission of filaments of nerves and small arteries.

Fig. 13. The malar bone of the right side, seen upon its internal surface: after Cheselden.

No. 1. The frontal process. 2. The orbital process. 3. The superior maxillary process. 4. The zygomatic process. 5. One of the foramina for the transmission of filaments of nerves and small arteries to the integument of the face.

Fig. 14. An anterior view of the palate bone.

No. 1. The horizontal portion of the palate bone. 2. Its perpendicular portion. 3. Its tuberosity. 4. The spheno-palatine foramen. 5. The orbital portion. 6. The sphenoidal portion. 7. The ridge that gives attachment to the inferior turbinated bone.

Fig. 15. A posterior view of the palate bone.

No. 1. The horizontal portion. 2. The perpendicular portion. 3. The tuberosity. 4. The surface which articulates with the external pterygoid plate. 5. The surface which articulates with the internal pterygoid plate. 6. The ridge that gives attachment to the inferior turbinated bone. 7. The spheno-palatine foramen. 8. The orbital portion. 9. The sphenoidal portion.

Fig. 16. An external view of the palate bone.

No. 1. The perpendicular portion. 2. The posterior palatine groove. 3. The posterior palatine foramen. 4. The tuberosity. 5. The spheno-palatine foramen. 6. The orbital portion. 7. The sphenoidal portion.

Fig. 17. The under surface of the palate portion of the palate bone.

No. 1. The palate spine. 2. The transverse ridge which gives attachment to the aponeurosis of the tensor palati muscle. 3. The posterior palatine foramen. 4. The tuberosity.

Fig. 18. The vomer.

No. 1. The broad and concave extremity, which articulates with the rostrum of the sphenoid bone. 2. The antero-superior border, which articulates with the central lamella of the ethmoid bone and with the cartilage of the septum. 3. The inferior border, for articulation with the palate processes of the superior maxillary and palate bones. 4. The posterior and free border of the vomer.

Plate 12.

Fig. 1.

Fig. 2.

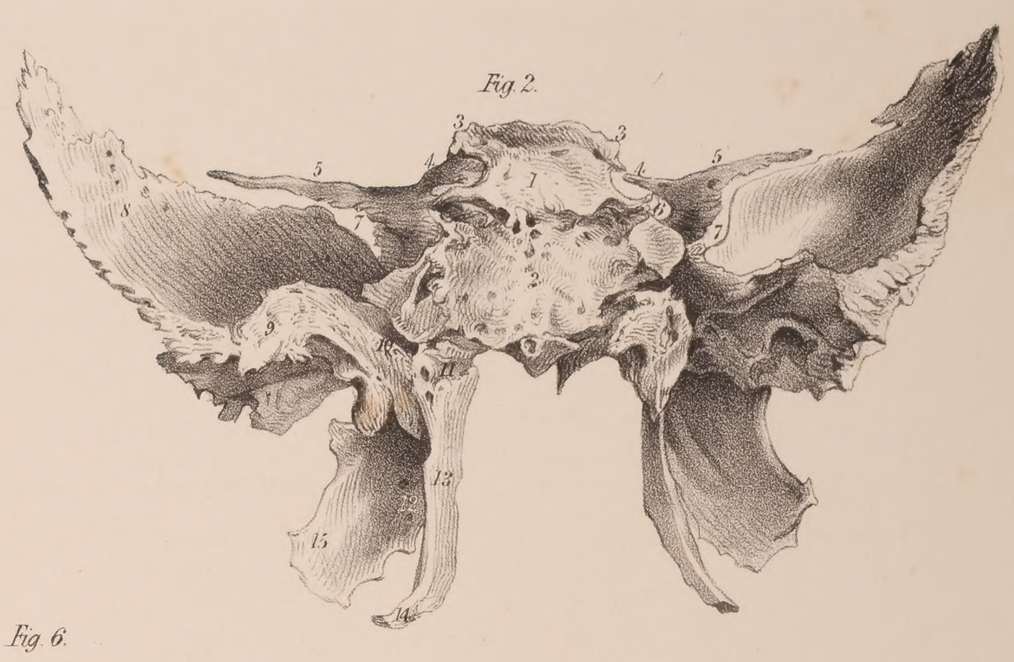

Fig. 5.

Fig. 6.

Fig. 3.

Fig. 12

Fig. 16.

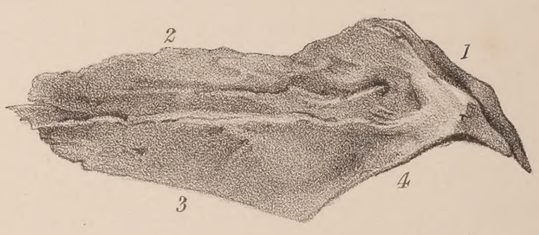

Fig. 11.

Fig. 8.

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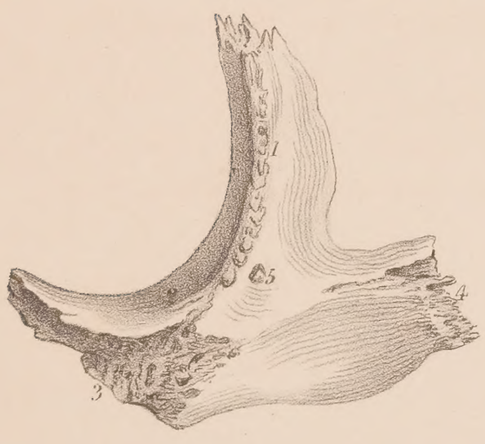

Fig. 9.

Fig. 10.

Fig. 7.

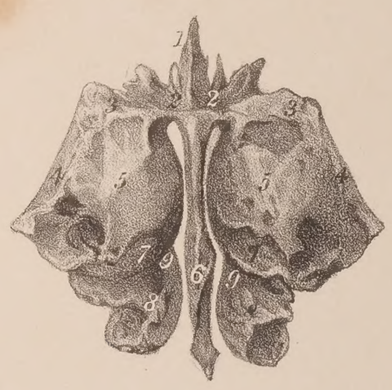

Fig. 4.

Fig. 14.

Fig. 16.

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Fig. 4.

Fig. 2.

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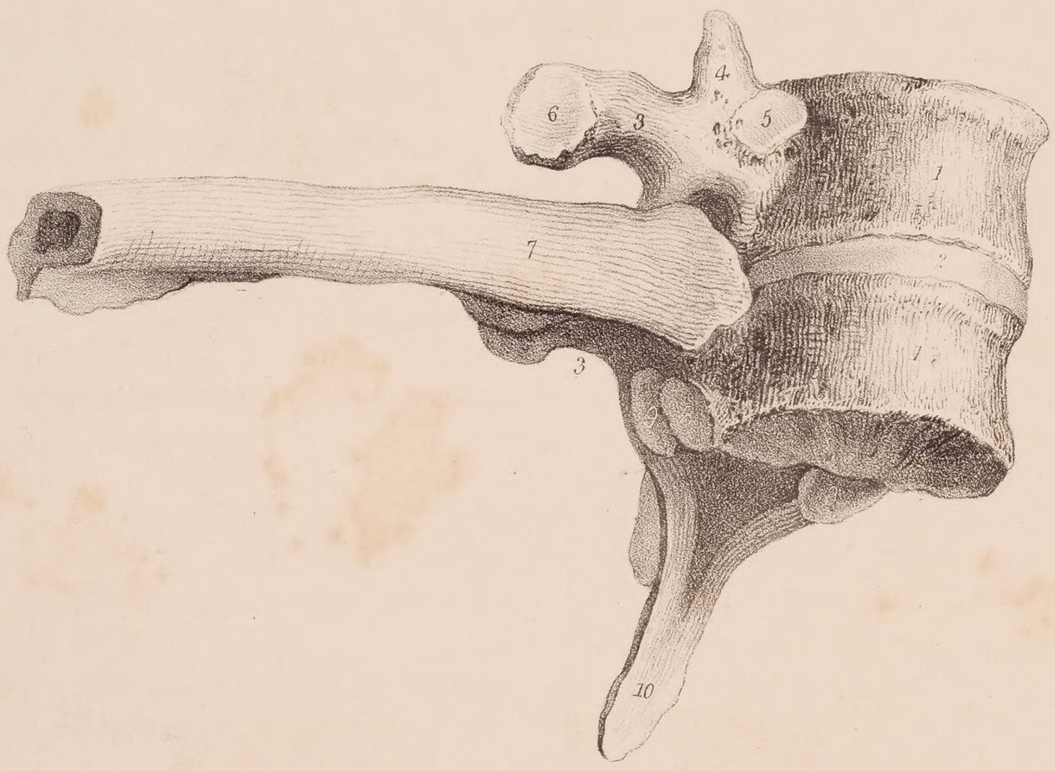

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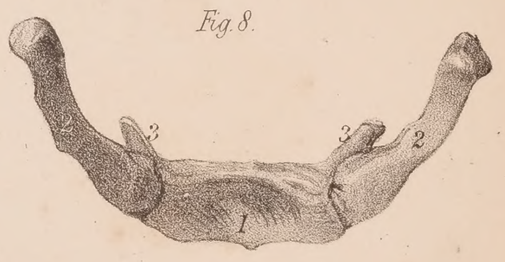

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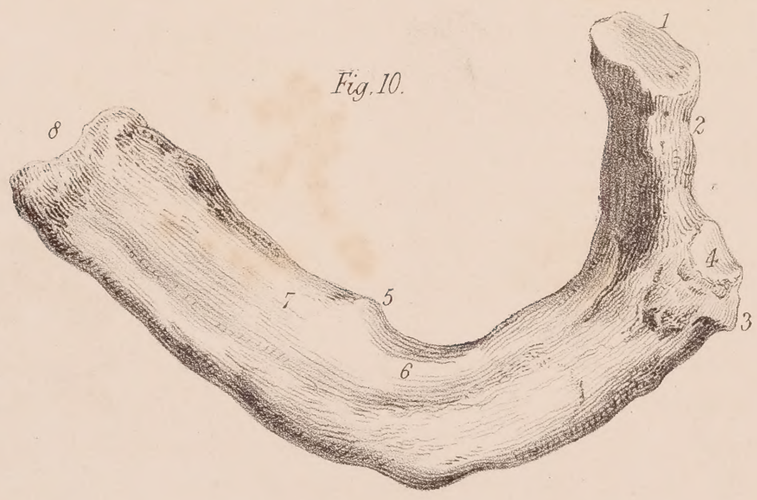

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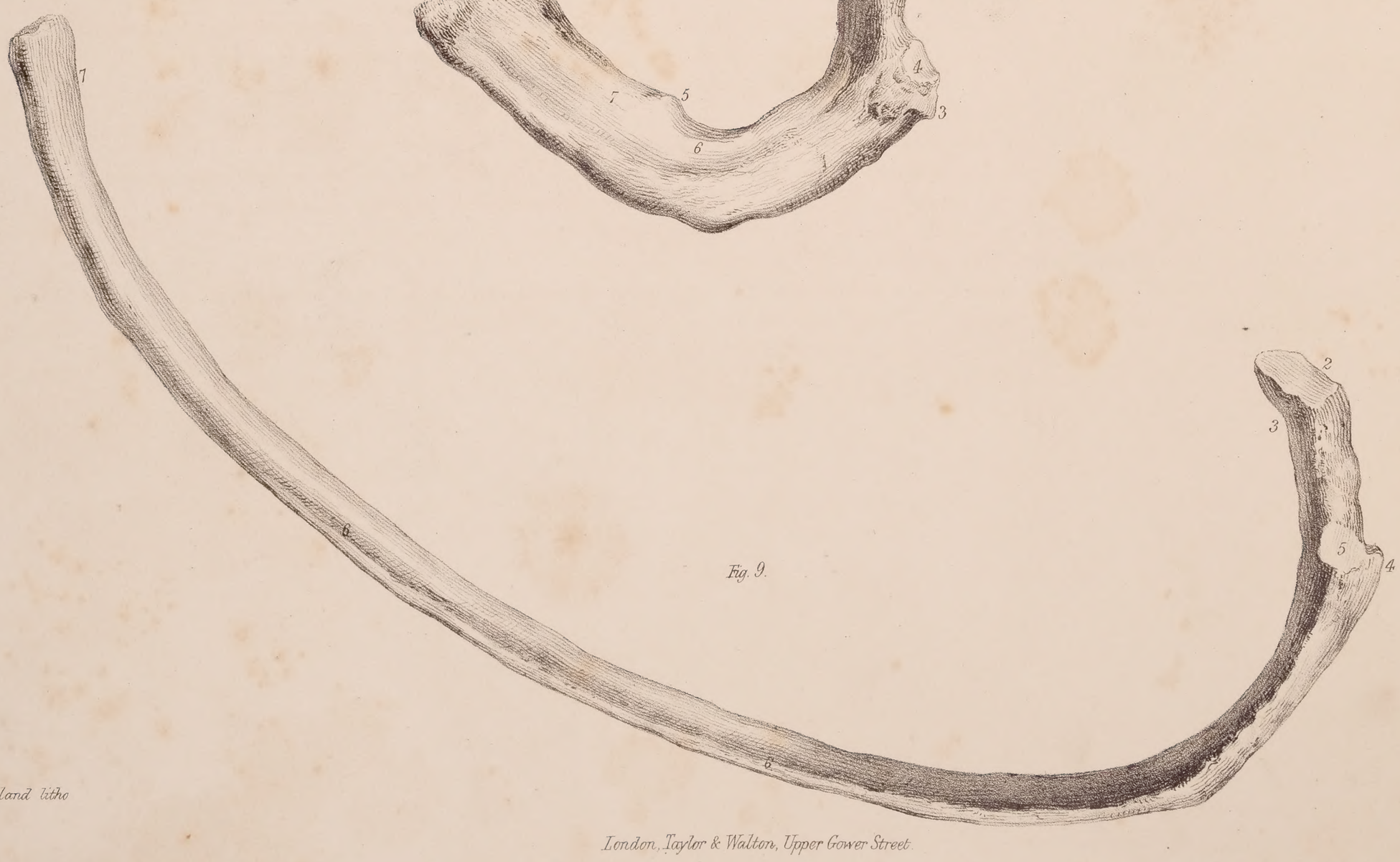

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process of the occipital bone and forms with it the jugular fossa. About the middle of this edge or border is a minute foramen, the opening of a small canal leading from the cochlea (*aquæductus cochleæ*).

PLATE XIII.

The bones of the upper and lower jaw; the teeth, the os hyoides, and the anatomical characteristics of a rib, are shown in this plate.

Fig. 1. The two superior maxillary bones articulated: after Cheselden.

No. 1. The body of the bone. 2. The canine fossa. 3. The infra-orbital foramen. 4. The incisive fossa. 5. The harmonial suture of the two bones. 6. The nasal spine. 7. The semi-lunar notch, forming the lateral boundary of the anterior nares. 8. The nasal process. 9. The concavity for the articulation of the lachrymal bone. 10. The malar process. 11. The tuberosity of the superior maxillary bone. 12. The median incisor of the right bone. 13. The lateral incisor. 14. The canine tooth. 15. The two bicuspidati, or small molars. 16. The three large molars. 17, 17. The alveolar process. 18. The left superior maxillary bone. 19. The opening of termination of the nasal duct. 20. The opening of the antrum of Highmore. 21. The notch for the reception of the nasal bones. 22. The palate process of the superior maxillary bone.

Fig. 2. The superior maxillary bone of the left side; a part of the bone has been removed in order to show the cavity of the antrum: after Cheselden.

The references from 1 to 16 are the same as in the preceding figure. 17, 17. The alveolar process. 18. The cavity of the antrum Highmori, laid open by the removal of a part of the anterior wall of the bone. 19. The orbital process. 20. The lachrymal tubercle.

Fig. 3. The left superior maxillary bone, with the palate and inferior turbinated bone; seen upon their nasal aspect: after Cheselden.

No. 1. The nasal surface of the superior maxillary bone. 2. The opening of the antrum. 3. The inferior turbinated bone, remaining attached to this surface. 4. The inferior meatus of the nose, into which the nasal duct opens. 5. The nasal process of the bone. 6. The semi-lunar notch for the articulation of the lachrymal bone. 7. The border of the orbital plate which articulates with the ethmoid bone. 8. The nasal surface of the perpendicular lamella of the palate bone. 9. The nasal spine. 10, 10. The palate process of the superior maxillary bone. 11, 11. The alveolar process. 12, 12. The palate process of the palate bone. 13. The palate spine. 14. The tuberosity of the palate bone. 15. Its hamular process. 16. The groove forming part of the naso-palatine canal.

Fig. 4. The inferior maxillary bone: after Cheselden.

No. 1. The body of the bone. 2. The symphysis. 3. The mental foramen. 4, 4. The alveolar process. 5, 5. The ramus of the lower jaw. 6, 6. Its angle. 7, 7. The coronoid process. 8, 8. The sigmoid notch. 9. Its condyle. 10. The neck of the condyle. 11. The inferior dental foramen. 12. The mylo-hyoidean ridge. 13. The median incisors. 14. The lateral incisor. 15. The canine. 16. The bicuspidati or small molars. 17. Two of the large molars, the third molar or dens sapientiæ has not yet appeared.

Fig. 5. The inferior maxillary bone; seen from within.

Nos. 1, 1. The body of the bone. 2. The symphysis. 3, 3. The rough surfaces for the attachment of the digastric muscles. 4. Tubercles for the attachment of the genio-hyoidei and genio-hyo-glossi muscles. 5, 5. The mylo-hyoidean ridge, at each side. 6, 6. The smooth surface against which the sublingual gland rests. 7, 7. The surface against which the submaxillary gland rests. 8, 8. The ramus of the inferior maxillary bone. 9, 9. Its angle. 10, 10. The inferior dental foramen. 11, 11. The mylo-hyoidean groove. 12, 12. The coronoid process. 13, 13. The sigmoid notch. 14, 14. The condyle. 15, 15. The neck of the condyle.

Fig. 6. The teeth of the upper and lower jaw: after Cheselden.

Nos. 1, 1. Median incisors. 2, 2. Lateral incisors. 3, 3. Canines. 4, 4. First bicuspidati. 5, 5. Second bicuspidati. 6, 6. First molars. 7, 7. Second molars. 8, 8. Third molars, or dentes sapientiæ. A. The second and third molars of the lower jaw closely locked together, and showing the recurved form of the fang which occasionally occurs. B. Section of a molar tooth, showing its anatomical structure. 1. The crown. 2. The neck. 3, 3. The roots or fangs. 4. The cavitas pulpæ.

Fig. 7. The os hyoides, viewed from the front.

No. 1. The body. 2, 2. The greater cornua. 3, 3. The lesser cornua.

Fig. 8. The os hyoides, viewed upon its inner aspect.

No. 1. The body. 2, 2. The greater cornua. 3, 3. The lesser cornua.

Fig. 9. The sixth rib: after Cheselden.

No. 1. Its shaft. 2. Its head. 3. Its neck. 4. Its tubercle. 5. The articular surface upon the tubercle. 6. The angle of the rib. 7. The groove along its lower border for the lodgment of the intercostal vessels and nerve. 8. The extremity which articulates with the costal cartilage.

Fig. 10. The first rib: after Cheselden.

No. 1. Its head. 2. The neck. 3. The tubercle. 4. The articular surface upon the tubercle. 5. The projection for the attachment of the tendon of the scalenus anticus muscle. 6. The groove for the subclavian artery. 7. The groove for the subclavian vein. 8. The extremity for articulation with the costal cartilages.

Fig. 11. Two of the dorsal vertebræ, with which a rib is articulated; the figure is intended to show the mode of articulation of these bones: after Cheselden.

Nos. 1, 1. The bodies of the vertebræ. 2. The inter vertebral substance. 3, 3. The transverse processes. 4. An articular process. 5. A half facet for the head of a rib. 6. The articular surface upon the extremity of the transverse process for the articulation of the tubercle of a rib. 7. A rib articulated with the vertebræ. 8. Another half facet for the articulation of the head of a rib. 9, 9. Inferior articular processes. 10. A spinous process.

Articulations.—The temporal bone articulates with the parietal, malar, inferior maxillary, sphenoid, and occipital bones.

Attachments of muscles.—To the zygoma is attached the masseter; to the squamous portion, the temporal; to the mastoid process, the retrahens aurem, the sterno-mastoid, splenius capitis, and trachelo-mastoideus; to the digastric fossa, the digastricus; to the styloid process, the stylo-glossus, stylo-hyoideus, and stylo-pharyngeus; to the apex of the petrous portion, the levator palati and tensor tympani.

Developement.—The squamous, mastoid, and petrous parts of the bone have each a separate ossific centre. So have the processes, viz. the zygomatic, styloid, and auditory.

The Sphenoid Bone.—The sphenoid is a single bone placed transversely at the base of the skull, and articulated with all the bones of the cranium and several of those of the face, between which it is inserted somewhat like a wedge, whence its name (σφην, a wedge; ειδος, like); its form has been likened to that of a bat with its wings extended; and the comparison is not very far-fetched, particularly if the ethmoid bone remains attached, as often happens. Like other irregular bones, it may be divided into body and processes.

To place this bone in its proper position so as to perceive clearly the relations of its different parts, observe that it has two thick processes somewhat like legs. Hold it so that these shall project downwards, as if from beneath the body and wings, and let those edges of the processes which are channelled into vertical grooves look backwards.

Of the body, or central part of the bone.—To give precision to its description, we say that it presents six aspects or surfaces, each of which looks in a different direction and has distinct relations:—The superior surface, which forms part of the basis of the skull, is of limited extent, yet is hollowed into a deep pit, which lodges the pituitary gland: hence this excavation is called *pituitary fossa*, and sometimes "sella Turcica," from some resemblance to a Turkish saddle (ephippium). On either side of the fossa the surface is depressed, and corresponds with the cavernous sinus; farther back are two superficial grooves, directed from behind forwards, which correspond with the internal carotid arteries. Before the fossa, is a slightly depressed portion of the bone, on a level with the optic foramina, on which rests the commissure of the optic nerves;—behind it is a prominent ascending lamella, of a square form, and sloping backwards, so as to be continuous with the basilar groove of the occipital bone: the corners of this lamella project over the fossa, and are called the *posterior clinoid processes* (κλινη, a bed).

The inferior surface is the narrow interval between the pterygoid processes; it is intersected by a prominent spine, called the *rostrum* or azygos process, which dips downwards and forwards to join the vomer. At each side are two small and slightly everted lamellæ (projecting from the base of the pterygoid processes), which articulate with the margins of the vomer. Farther out is a small groove, which contributes with the head of the palate bone to form the *pterygo-palatine canal.*

The anterior surface is very irregular, and presents the openings of two deep sinuses, into which the bone is hollowed: these sinuses (*sphenoidal*) do not exist in young children; in the adult, in whom they are of considerable size, they are separated by a thin partition (septum sphenoidale), which is continuous inferiorly with the rostrum, and in the front articulates with the central lamella of the ethmoid bone. The sinuses are covered in anteriorly by two thin osseous plates, the *sphenoidal spongy bones* (cornua sphenoidalia, cornets sphenoidaux); these do not, however, altogether seal up the sphenoidal sinuses, but leave a circular aperture, by which they communicate with the posterior ethmoidal cells. In early life they are distinct, and easily separable; but in the adult they become united either with the margins of the sinuses or with the ethmoid or the palate bone.

The posterior surface is flat, and united with the basilar process of the occipital bone,— in early life by cartilage, but in adult age by osseous matter.

The lateral surfaces are continuous with the great wings, which branch out from them on either side.

Of the Processes.—The principal processes are, the great wings, the small wings, and the pterygoid processes; the minor ones are the ethmoid spine, processus olivaris, clinoid processes, the rostrum, the hamular and spinous processes.

The *great wings* (alæ majores) project outwards, forwards, and upwards, from the sides of the body of the bone, and are so formed as to present each three surfaces, looking in different directions; one, anterior, (*orbital,*) is square, smooth, inclined obliquely forwards, and forms part of the outer wall of the orbit; the second, (superior or *cerebral,*) of much greater extent, is elongated from behind forwards, and concave, so as to form part of the middle fossa of the basis of the skull, which supports the middle lobe

of the brain; the third (external or *temporal*) looks outwards into the temporal fossa, where it forms part of the side of the cranium. It is elongated from above downwards, and slightly hollowed. But it will be observed that this surface, taken as a whole from the top of the wing down to the root of the pterygoid process, presents two parts divided by a slight ridge; of these the upper and longer one just noticed forms part of the temporal fossa, and the inferior or smaller division, of the zygomatic fossa.

The *small wings*, (alæ minores,) called also wings of Ingrassias, are triangular in form, horizontal in direction, and extended forwards and outwards, on a level with the upper surface of the body — its fore-part. Their upper surface, plain and flat, supports part of the anterior cerebral lobes, the inferior one overhangs the back part of the orbit and the sphenoidal fissure. The anterior border, sharp, thin, and rough, articulates in the greater part of its extent with the orbital plate of the frontal bone, and internally, at the middle line, where the bases of the two processes are united, there is a slight angular process, (*ethmoidal spine*,) which articulates with the cribriform lamella of the ethmoid bone. The posterior border, rounded and smooth, is free and unattached, and corresponds with the fissure (fissura Sylvii) which separates the anterior from the middle lobe of the brain. The external and anterior ends of these processes are sharp and pointed, whilst posteriorly they terminate in two blunt tapering productions, which incline obliquely backwards, towards the pituitary fossa, and overlie the cavernous sinuses. These are called *anterior clinoid processes*.

The *pterygoid* processes are seen at the inferior surface of the bone, from which they project down like legs rather than wings, though the name given to them would indicate the reverse (πτερυξ, a wing). Each of these consists of two narrow plates (*pterygoid lamellæ*), united at an angle in front, and diverging behind, so as to form an angular groove (*pterygoid fossa*). The internal plate, longer and narrower than the external, is prolonged into a slight round process, named, from its crooked form, the hook-like or *hamular process*, round which plays the tendon of the tensor palati muscle. The external lamella looks outwards, and somewhat forwards, bounds the zygomatic fossa, and gives attachment to the external pterygoid muscle. At the root of the internal lamella is situated a slight depression (*fossa navicularis*), which gives attachment to the tensor palati muscle; in the groove or fossa, between the two plates, arises the internal pterygoid muscle. The groove is incomplete at its lower part when the sphenoid bone is examined by itself; for an angular interstice exists between the pterygoid lamellæ. This, however, is filled up by a part of the pyramidal process of the palate bone, which is inserted between the margins of the lamellæ.

The *ethmoid spine*, already noticed, is a very small angular plate, which projects forward on a level with the upper surface of the lesser wings in the middle line, and articulates with the cribriform lamella of the ethmoid bone.

The *processus olivaris* is a minute elevation seen on that depressed piece of bone on a level with the optic foramina, and which supports the commissure of the optic nerves.

The *clinoid* processes are two pair, one before, the other behind the pituitary fossa; therefore called anterior and posterior. A spicula of bone often passes from the anterior to the posterior clinoid process at one or both sides; and occasionally one dips down from this to the body of the bone.

The *rostrum* is the prominent angular ridge, which projects downwards from the under or guttural surface of the bone, dividing it into two parts.

The *hamular* process projects from the termination of the internal pterygoid plate, is thin, constricted, and curved in the greater part of its extent, but ends in a small blunted tubercle.

The *spinous* processes are placed at the posterior and inner terminations of the great wings, from which they project downwards about two lines.

Each lateral half of the bone presents a fissure, four foramina, and a canal. The fissure, (*fissura sphenoidalis*,) triangular and elongated, is placed between the lesser and greater wings, opens into the orbit, (hence sometimes named foramen lacerum orbitale,) and transmits the third, the fourth, and the sixth nerves, the ophthalmic branch of the fifth and the ophthalmic vein. This fissure is separated at its base from the foramen opticum by a narrow plate of bone which passes from the under surface of the anterior clinoid process (at its root) obliquely down to the body of the sphenoid bone; to this is attached a small tendon, common to the inferior, internal, and external recti muscles of the eye. Of the foramina, — the optic foramen inclines outwards and forwards on a level with the fore-part of the body of the bone; it transmits the optic nerve and the ophthalmic artery. Farther back and on a lower plane, inasmuch as it is situated in the great wing, is a round aperture, leading forwards; it is the *foramen rotundum*, which transmits the superior maxillary branch of the fifth pair of nerves: a little farther back and more external is a larger foramen, of an oval form, hence called *foramen ovale;* it gives passage to the inferior maxillary branch: near the posterior angle of the ala is the *foramen*

spinosum ; it is very small, and transmits the middle meningeal artery. The root, or base, of each internal pterygoid process is pierced by a circular foramen, (*pterygoideum*,) more properly a canal, extending horizontally from before backwards, slightly expanded before, narrowed behind, and giving passage to the posterior branch from Meckel's ganglion (*Vidian, pterygoid*).

Articulations.—The body of the sphenoid bone articulates posteriorly with the basilar process of the occipital, anteriorly with the ethmoid; with the orbital processes of the frontal by the lesser and greater alæ; with the anterior inferior angles of both parietal, and the squamous portion of the two temporal, by the great alæ, and by the spinous processes with the angles between the petrous and squamous portions of that bone: with the vomer it articulates by the rostrum; with the malar bones by means of the external border of the orbital plates, and with the palate bones by the pterygoid processes;—in all, twelve bones.

Attachments of muscles.—Round the optic foramen in each orbit are attached the four recti, the obliquus superior, and levator palpebræ muscles; to the external surface of the great ala at each side, the temporal muscle; to the external pterygoid process, the external pterygoid muscle; to the pterygoid fossa, the internal pterygoid; to the inferior half of the internal pterygoid plate, the superior constrictor of the pharynx; and to the fossa navicularis, the circumflexus palati; and to the spinous process, the laxator tympani.

Developement.—There are two osseous centres in the great wings, two in the pterygoid processes, and two in the small wings. The anterior and posterior segments of the body of the bone commence by distinct points; and as these in some instances unite, one with the great wings and the other with the small ones, before they become joined to one another, this condition of the bone presents an analogy with its permanent state in fishes, reptiles, and most mammalia, in which we find an anterior and posterior sphenoid bone. There appear also two osseous points at the inner borders of the optic foramina.

Ethmoid Bone.—The *ethmoid*, or sieve-shaped bone, (ηθμος, a sieve; ειδος, like; os ethmoides,) is common to the cranium, the orbits, and the nasal fossæ; it is placed at the fore-part of the base of the skull, from which it projects downwards, and is inserted between the orbital plates of the frontal bone, lying behind the nasal and superior maxillary bones, before the sphenoid and above the vomer. It is exceedingly light and thin, considering its size; and seems, at first, but a collection of irregular cells, enclosed between plates of bone as thin as paper. It is of a cuboid figure, symmetrical, and composed of two lateral masses, between which is interposed a central vertical plate. This points out a mode of dividing the bone for the purpose of description, but it is more convenient to consider it as a whole, and examine separately each of its six surfaces.

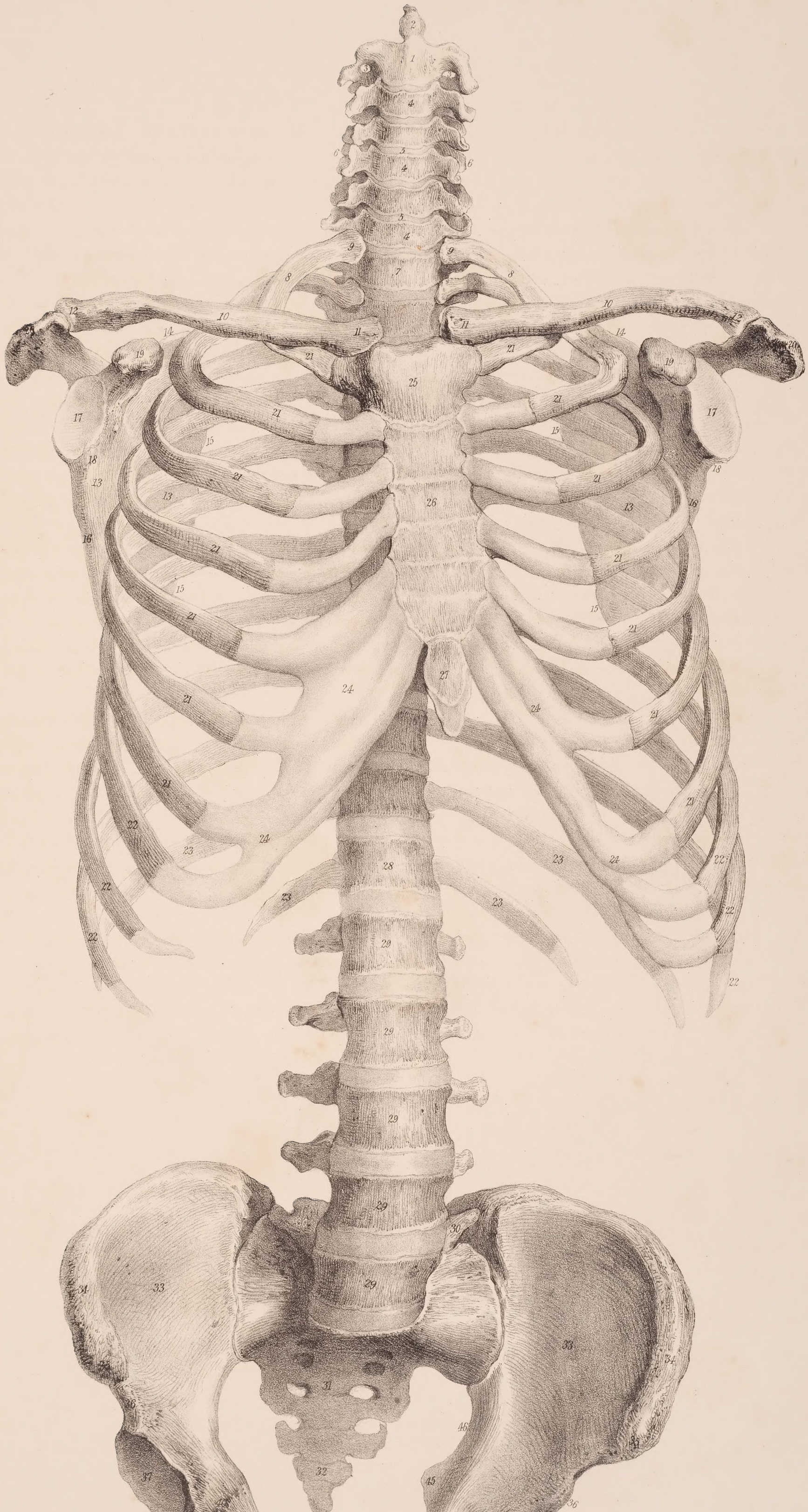
To place the bone in its proper position, observe that its upper surface is the one from which arises a smooth angular process like a cock's comb. The short border of this looks forward, and the long sloping one backwards.

The superior, or *cerebral* surface of the bone, is at once recognised by its presenting a triangular process, which projects upwards from it, in the middle line; this process, from some resemblance to a

PLATE XIV.

An anterior view of the trunk of the skeleton: after Cheselden.

No. 1. The axis. 2. Its odontoid process. 3, 3. The foramen in its transverse process for the passage of the vertebral artery. 4, 4. The bodies of the cervical vertebræ. 5, 5. Their intervertebral substance. 6, 6. The transverse processes, with their anterior and posterior tubercles. 7. The body of the first dorsal vertebra. 8, 8. The first rib. 9, 9. The head of the first rib, which in this subject would seem to articulate with the last cervical vertebra. 10, 10. The clavicle. 11, 11. Its rounded or sternal extremity. 12, 12. Its flattened or scapular end. 13, 13. The anterior surface of the scapula. 14, 14. Its superior or short border. 15, 15. Its posterior border or base. 16, 16. Its anterior border. 17, 17. Glenoid cavity. 18, 18. The neck of the scapula. 19, 19. The coracoid process. 20, 20. The acromion process. 21, 21. The seven true ribs. 22, 22. The false ribs. 23, 23. The two floating ribs. 24, 24. The costal cartilages. 25. The first piece of the sternum. 26. The middle piece. 27. The ensiform cartilage. 28. The last dorsal vertebra. 29, 29. The bodies of the five lumbar vertebræ. 30, 30. Their transverse processes. 31. The sacrum. 32. The coccyx. 33, 33. The os ilium. 34, 34. Its crest. 35, 35. The anterior and superior spinous process. 36, 36. The anterior inferior spinous process. 37. The acetabulum of the right side. 38, 38. The body of the os pubis. 39, 39. Its crest. 40, 40. The ilio-pectineal eminence. 41. The symphysis pubis. 42, 42. The ramus of the pubis at each side. 43, 43. The ramus of the ischium. 44. The tuberosity of the ischium. 45. The spine of the ischium. 46. The great sacro-ischiatic notch. 47, 47. The obturator foramen.



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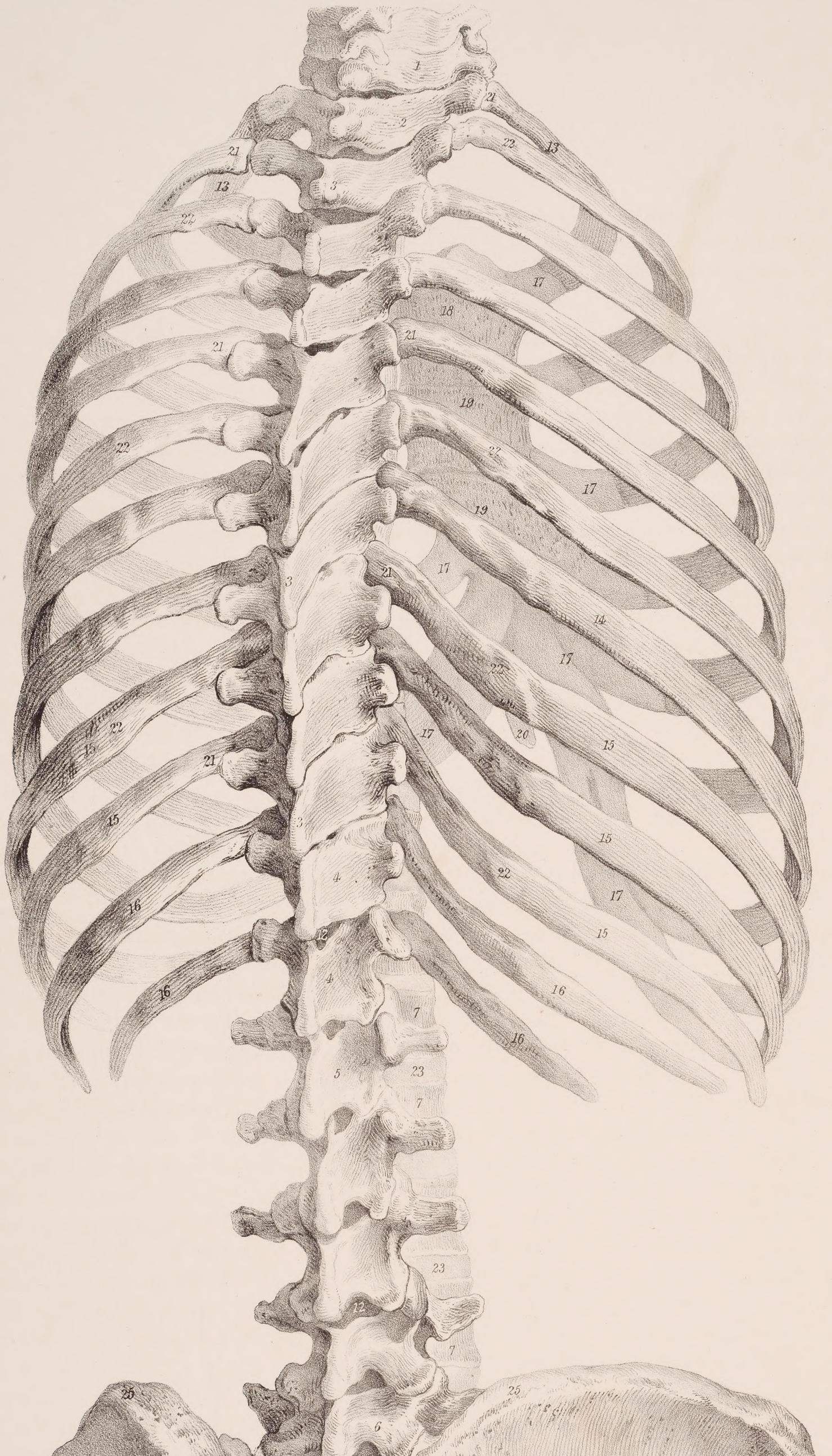

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cock's comb, is called *crista galli*. The surface of the crista is smooth and compact, its form triangular, the base being horizontal, and on a level with the cribriform plate, below which it is continuous with the perpendicular lamella forming the septum narium; the posterior border of this process is long, and slopes backwards, but the anterior is short, and nearly perpendicular; at its junction with the base two small bony masses sometimes project forwards, leaving between them a fissure which forms part of the "foramen cæcum," placed in the middle line at the junction of this bone with the frontal. The crista galli is usually perpendicular, but occasionally inclines to one side; it is sometimes bulged a little at the sides, and is then found to enclose a small sinus; it gives attachment to the falx cerebri, the two layers of which in a manner embrace it.

Beside and behind the crista is the sieve-like or *cribriform lamella* (lamella cribrosa). It consists of a narrow plate of bone, pierced by a number of holes, from which it derives its name; posteriorly this plate of bone is, for a very little way, even and horizontal; it then becomes depressed into two grooves, beside the crista, which lodge the ganglia of the olfactory nerves. This part of the surface is narrow, elongated from behind forwards, and pierced by numerous foramina, for the transmission of the filaments of the olfactory nerves. The foramina in it are of three sorts: those which lie along the middle of the groove are mere holes or perforations which permit the filaments of the nerves, with their membranous investments, to pass down to the roof of the nares; the external and internal rows are larger, and form the orifices of small canals, which are grooved in the bone, and subdivide as they descend into the septum and spongy bones. In the anterior border of the cribriform lamella, and close to the crista galli, is a fissure at each side of its base, which transmits the nasal filament of the ophthalmic nerve. Along the outer margin of the cribriform plate we observe several small cellules, which are open, and, as it were, incomplete when the bone is detached from its natural situation, but are closed in by the orbital plates of the frontal bone, and completed by a junction with the cells observed in their border. At the posterior margin of this surface, and in the middle line, is a slight notch, which receives the ethmoid spine of the sphenoid bone.

The anterior surface of the bone presents in the middle the edge of the perpendicular or nasal lamella; at the sides of this are narrow grooves which separate it from the lateral masses, and form the upper part of the nasal fossæ; still farther out are some open cellules, which when the bone is in its place are closed by the ascending process of the superior maxillary bone.

The posterior surface presents also in the middle the edge of the perpendicular lamella, then the grooved posterior margins of the ethmoidal turbinate bones, and still more externally large open cellules which are closed by the sphenoid bone and its turbinate bones, and lower down by the head of the palate bones.

The lateral or orbital surfaces are smooth and plain; each is formed of a thin plate of bone, (*lamella plana, os planum,*) which lies in the inner wall of the orbits.

Thus far we can proceed with our description of the bone as if it were a single piece, which presented several aspects, each requiring to be noticed; but when we look at it from below we find it expedient to consider it as divisible into a central or median plate, and two lateral parts or masses.

PLATE XV.

A posterior view of the trunk of the skeleton: after Cheselden.

No. 1. The last cervical vertebra. 2. The first dorsal vertebra. 3, 3. The spinous processes of the dorsal vertebræ, showing their imbricated position. 4, 4. The two last dorsal vertebræ, showing their approximation in form to the lumbar vertebræ and their exceedingly short transverse processes. 5. The first lumbar vertebra. 6. The last lumbar vertebra. 7, 7. The bodies of the lumbar vertebræ. 8, 8. The sacrum. 9. The first piece of the coccyx. 10, 10. The posterior sacral foramina. 11. The termination of the sacral canal. 12, 12. The spaces between the arches of the vertebræ, which are closed in the fresh subject by the ligamenta subflava. 13, 13. The first rib. 14, 14. The seventh and last true rib. 15, 15. The three upper false ribs. 16, 16. The two last false ribs,—the floating ribs. 17, 17. The costal cartilages. 18. The first piece of the sternum. 19, 19. The sternum. 20. The ensiform cartilage. 21. 21. The tubercles of the ribs articulating with the extremities of the transverse processes of the ten upper dorsal vertebræ. 22, 22. The angles of the ribs; the surface between the tubercles and the angles is rough for the attachment of muscles. 23, 23. The inter-vertebral substance, situated between the vertebræ. 24. The ilium. 25, 25. Its crest. 26. The posterior superior spinous process. 27. The posterior inferior spinous process. 28. The anterior inferior spinous process. 29. The border of the acetabulum. 30. The great sacro-ischiatic notch. 31, 31. The ischium. 32. The spine of the ischium. 33. The lesser sacro-ischiatic notch. 34. The tuberosity of the ischium. 35. The ramus of the ischium. 36. The os pubis. 37. Its ramus. 38. The symphysis pubis. 39, 39. The ilio-pectineal line. 40. The obturator foramen.

The inferior, or *nasal* surface of the bone, is of considerable extent, and presents in the middle line a flat plate of bone, and two lateral masses separated from it by a narrow interval: these lateral parts are formed of thin plates, enclosing cellules, which appear so complex as to be likened by some persons to a labyrinth. The descending or *nasal* plate (lamella nasalis), called also the perpendicular plate, though it frequently inclines to one side, forms a considerable part of the septum nasi; it is continuous above with the base of the crista galli, as already stated; below, it articulates with the vomer and the triangular cartilage of the nose; its anterior margin joins by its upper part with the nasal process of the frontal bone, and lower down supports the ossa nasi; the posterior margin articulates with the septum sphenoidale. This plate presents a number of grooves and minute canals, leading from the foramina of the cribriform lamella, for the transmission of the olfactory nerves: in the natural condition it is covered by the pituitary membrane.

Lateral masses.—The external surface of each of these consists of a thin, smooth, and nearly vertical plate of bone, (*lamella plana, os planum,*) which closes in the ethmoidal cells, and forms a considerable part of the inner wall of the orbit: it articulates above with the orbital plate of the frontal bone; below, with the superior maxilla and palate bone; in front, with the os unguis; and behind, with the sphenoid. At its anterior and posterior margins, the ethmoidal cells are open when the bone is detached from its connexions; in the former situation they are closed by the os unguis; in the latter by the sphenoid spongy bones. In its upper margin are two grooves, which are formed into foramina by similar indentations in the frontal bones, and so form the internal orbital foramina (*foramen orbitarium internum, anterius et posterius*).

The inner surface of each lateral mass forms part of the external wall of the corresponding nasal fossa, and consists of a thin osseous plate, connected above with the cribriform lamella, from which it hangs down, and below ends in a free margin, which is convoluted a little, and represents the middle spongy bone. At its upper and fore part is a square, flat, but rough surface, which is pierced by a number of grooves, leading from the foramina of the cribriform lamella; posteriorly are placed two thin and also rough osseous plates, curved a little, so as to represent small bivalve shells, from which circumstance they are called ethmoidal *turbinate* bones; but from their texture, being cellular and porous on the surface, they are named spongy bones. Of these, the first or upper one, (concha superior,) which is also placed farther back, is very small; by the curve or coil which it makes it arches over, and forms a groove or channel (*meatus naris superior*): this is of small extent from before backwards, not being more than half that of the ethmoid bone; it communicates with the posterior ethmoidal cells, and the sphenoidal sinuses. Still lower down is another osseous lamella, thin, rough, and convoluted, which is the second ethmoidal spongy or turbinate bone. Its lower margin is more rough and prominent than that of the upper one, and its extent from before backwards nearly double. Beneath this is a groove or channel which it overhangs so as to form the second *meatus naris*, which communicates with the anterior ethmoidal cells and the frontal sinuses.

The osseous rough plate here described gives attachment by its outer surface to a number of osseous lamellæ, thin and delicate, which pass across the space between it and the lamella plana, dividing it into a number of cells (*ethmoidal*). These do not all communicate: they are separated into two sets by a sort of transverse partition, the posterior being small and few in number—from four to five,—whilst the anterior, larger and more numerous, communicate with the frontal sinus. The cellule, which directly communicates with the middle meatus, is prolonged, in a curved direction, upwards and forwards, opening by a small aperture into the anterior ethmoidal cells, and by another, farther on, into the frontal sinus; and, as it is broad below and tapering above, it assumes somewhat the form of a funnel, and hence is named *infundibulum*.

The superior border of each lateral mass presents some incomplete cells, before noticed, when describing the cribriform plate; the inferior gives off some irregular lamellæ, which articulate with the side of the maxillary sinus and the inferior turbinate bone; the anterior also exhibits some incomplete cells, which are closed in by the os unguis and the nasal process of the superior maxillary bone.

Articulations.—The ethmoid articulates with thirteen bones—the frontal, the sphenoid, and vomer, two nasal, two ossa unguis, two superior maxillary, two palatal, and two inferior spongy bones.

Developement.—There is an ossific centre in each lateral mass, and one in the perpendicular lamella.

Ossa triquetra.—Accidental, or supernumerary bones, are not unfrequently found in skulls. From their form, which is very variable, they are sometimes called triquetra, at others, triangularia, or ossa Wormii, from Wormius the anatomist, who is said to have given the first detailed description

of them. They are osseous plates, with serrated margins, inserted, as it were, between two cranial bones, and appearing like islets placed in the sutures. Their most ordinary position is in the lambdoid suture, next in the sagittal, seldom if ever in the coronal, never in the squamous. The superior angle of the occipital bone sometimes occurs as an accessory piece; so does the anterior inferior angle of the parietal. They are not found before the sixth or eighth month after birth; and, whatever varieties of size and appearance they may present, the principle of their formation is the same in all cases. As the broad bones grow by successive deposits, extending from their central points towards the margins, whenever the natural process is retarded or interrupted, the mode of osseous deposition takes a new direction, a new centre is established in the layer of cartilage between the margins of the bones, and therefore in the situation of the suture, from which it extends outwards, until it comes into contact with the margins of the contiguous bones, with which it becomes united in the usual way by suture.

Bones of the face. — The bones of the face are fourteen in number.

The superior maxillary bone. — This bone (maxilla superior) is very irregular; it presents an external convex surface, corresponding with the anterior and lateral parts of the face; another, internal, of considerable extent, corresponding with the nasal cavity; one, superior, smooth, and inclined inwards, forming the floor of the orbit, and surmounted internally by a triangular process, forming the side of the nose; lastly, a surface which projects horizontally inwards, to form the arch of the palate. The external surface is bounded inferiorly by a thick dependent border (alveolar), for the lodgment of the teeth; to this, as to a common point of union, all the other parts of the bone may be referred.

The alveolar border, thick, semicircular, convex externally, concave internally, is pierced along its margin by a number of deep pits (*alveoli*), into which the teeth are inserted. The pits or sockets vary in form and depth, conforming in these particulars to the roots of the teeth which they receive. From this border the external side ascends upwards to the margin of the orbit, presenting some depressions and elevations; but at its fore part it is interrupted and excavated so as to present a deeply concave margin, which, with a similar one in the corresponding bone, forms the anterior nares. This excavation is surmounted by a process, (*ascending* or *nasal*,) prolonged as far as the frontal bone, with which it articulates. The external surface of this process, slightly grooved, gives attachment to the orbicularis palpebrarum muscle and the levator labii superioris alæque nasi. The internal, or nasal surface, somewhat concave, presents a rough line, running from before backwards, which articulates with the inferior spongy bone; above this is a depression corresponding with the middle meatus of the nose, and, towards the summit, a rough surface, which closes in the anterior ethmoidal cells. The anterior border is rough, for its attachment to the nasal bone; the posterior presents a well-marked groove, running from above downwards, and a little backwards with a slight curve, and which is completed into a canal by a similar one in the os unguis, for the lachrymal sac.

The part of the external surface a little above the molar teeth is elevated into a rough projection, (*malar eminence*,) for its articulation with the malar bone. Anterior and inferior to this is observed a fossa, (*fossa canina*,) which gives attachment to the levator anguli oris. Between this fossa and the margin of the orbit is the infra-orbital foramen, which transmits the superior maxillary nerve. A little above the sockets of the incisor teeth is a slight depression, (myrtiform fossa,) which gives attachment to the depressor muscle of the ala of the nose. Behind the malar tuberosity the surface is slightly excavated, and forms part of the zygomatic fossa; towards the posterior border it is plain, and forms one side of the spheno-maxillary fissure; and, at its junction with the orbital plate, it is rounded off and leads to the entrance of the infra-orbital canal. This surface is pierced by a number of foramina, which transmit the superior dental nerves; it terminates by a slight tuberosity, which projects behind the last molar tooth. The inner surface of its posterior border is rough, for its attachment to the tuberosity of the palate bone, and presents also a slight groove, contributing to the formation of the *posterior palatine canal*, which transmits the descending palatine branches from Meckel's ganglion.

From the upper border of the external surface, the *orbital plate* projects inwards, forming the floor of the orbit; its surface is smooth, being merely interrupted by the groove which leads to the infra-orbital canal; and at its inner and fore part near the lachrymal groove is a minute depression, which gives origin to the inferior oblique muscle of the eye.

The horizontal or *palate* plate of the bone projects inwards, forming the roof of the mouth, and the floor of the nares. Its nasal surface is concave from side to side, and smooth; externally it is continuous with the body of the bone, internally it presents a rough surface, which is articulated

with the corresponding bone, and surmounted by a ridge, which completes the septum narium by articulating with the vomer and nasal cartilage; in front it is prolonged a little, so as to form a small process (anterior nasal spine); beside it is the foramen, leading into the anterior palatine canal, which lodges the naso-palatine ganglion. The inferior surface of the palate plate is rough, arched, and overhangs the mouth.

The body of the bone is hollowed into a large cavity, *antrum Highmori*, or *maxillare*, which in the fresh state is lined by mucous membrane and communicates with the middle meatus of the nose. Its orifice appears of great size in the dried bone when detached from its connexions, but it is considerably diminished when the contiguous bones are in their natural position, viz. the ethmoid, the inferior turbinate, and the palatal.

Articulations.—With the corresponding bone; with the frontal, by its nasal process; also with

PLATE XVI.

The clavicle and scapula, with the ligaments of the sterno-clavicular articulation and shoulder joint.

Fig. 1. The clavicle of the left side of the skeleton.

No. 1. The sternal extremity. 2. Its articulating surface. 3. Its scapular end. 4. The surface which articulates with the acromion process.

Fig. 2. The under surface of the same clavicle.

No. 1. The surface which articulates with the sternum. 2. The rough surface for the attachment of the rhomboid ligament. 3, 3. The grooved surface for lodging the subclavius muscle. 4. The rough surface for the attachment of the coraco-clavicular ligament. 5. The scapular end of the clavicle.

Fig. 3. The scapula of the left side; its dorsal aspect.

No. 1. The superior border of the scapula. 2. The superior angle of the scapula. 3, 3. Its posterior border. 4, 4. The spine. 5. The triangular smooth surface at the commencement of the spine, over which the trapezius glides upon a bursa. 6. The acromion process. 7. The supra-spinatus fossa. 8. The infra-spinatus fossa. 9. The neck of the scapula. 10. The glenoid fossa. 11. The apex of the glenoid fossa, to which the long tendon of the biceps is attached. 12. The coracoid process. 13. The anterior or inferior border of the scapula. 14. The rough surface from which the middle head of the triceps muscle arises. 15. The surface for the attachment of the teres minor muscle. 16. The surface for the attachment of the teres major muscle. 17. The inferior angle of the scapula.

Fig. 4. The anterior surface of the scapula of the left side.

No. 1. The superior border of the scapula. 2. The supra-scapular notch. 3. The superior angle of the bone. 4, 4. Its posterior border. 5. The inferior angle. 6, 6. The anterior or inferior border. 7, 7. The concave surface of the venter of the scapula. 8. The neck of the scapula. 9. Its glenoid cavity. 10. The rough ridge which gives attachment to the long head of the triceps muscle. 11. The coracoid process. 12. The acromion process. 13. The smooth surface which articulates with the scapular end of the clavicle. 14. The spine of the scapula.

Fig. 5. An anterior view of the sterno-clavicular and costo-sternal articulations.

Nos. 1, 1. The sternal extremities of the clavicles. 2, 2. The anterior sterno-clavicular ligaments. 3. The inter-clavicular ligament. 4, 4. The costo-clavicular or rhomboid ligaments. 5, 5. The first rib at each side. 6, 6. The costal cartilages of the second and third ribs. 7, 7. Anterior costo-sternal ligaments.

Fig. 6. A posterior view of the sterno-clavicular and costo-sternal articulations.

Nos. 1, 1. The posterior sterno-clavicular ligaments. 2. The inter-clavicular ligament. 3, 3. The costo-clavicular or rhomboid ligaments. 4, 4. The posterior costo-sternal ligaments. 5, 5. The superior costo-sternal ligaments. 6, 6. The inferior costo-sternal ligaments.

Fig. 7. An anterior view of the ligaments of the shoulder joint.

No. 1. A part of the scapula. 2. The upper part of the humerus. 3. A part of the scapular end of the clavicle. 4. The scapulo-clavicular articulation. 5. Its inferior ligament. 6. The coracoid process. 7. The coraco-clavicular or trapezoid ligament. 8. The under surface of the acromion process. 9. The coraco-acromial ligament. 10. The transverse or coracoid ligament, converting the supra-scapular notch into a foramen. 11. The capsular ligament of the shoulder joint. 12. The coraco-humeral ligament. 13. The tendon of the sub-scapularis muscle. 14. The tendon of the long head of the biceps, escaping from the shoulder joint.

Fig. 8. A posterior view of the shoulder joint.

No. 1. The spine of the scapula. 2. Its acromion process. 3. The scapular extremity of the clavicle. 4. The superior scapulo-clavicular ligament. 5. The coracoid process. 6. The coraco-clavicular ligament, or conoid ligament. 7. The transverse or coracoid ligament crossing the supra-scapular notch. 8. The supra-scapular foramen. 9. The superior border of the scapula. 10. The coraco-acromial ligament. 11. The capsular ligament of the shoulder joint. 12. The tendon of the supra-spinatus muscle. 13. The tendon of the infra-spinatus. 14. The tendon of the teres minor. 15. The neck of the humerus.

Fig. 9. A portion of the scapula, showing the glenoid cavity and ligament.

No. 1. The acromion process. 2. The coracoid process. 3. The glenoid cavity. 4, 4. The glenoid ligament. 5. The tendon of the long head of the biceps.

Fig. 10. A section of the shoulder joint, showing the interior of its cavity.

No. 1. The anterior surface of the scapula. 2. The head of the humerus. 3. Part of the glenoid cavity. 4, 4. The cut border of the capsular ligament. 5. The tendon of the long head of the biceps, passing through the cavity of the joint. 6. Part of the glenoid ligament.

Plate 16.

Fig. 7.

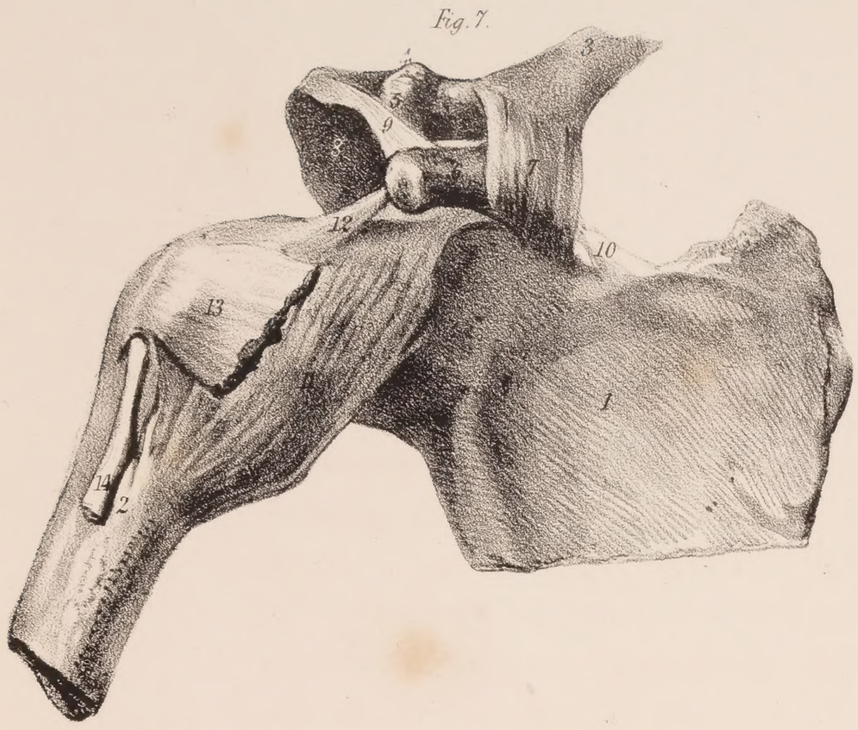


Fig. 9.

Fig. 8.

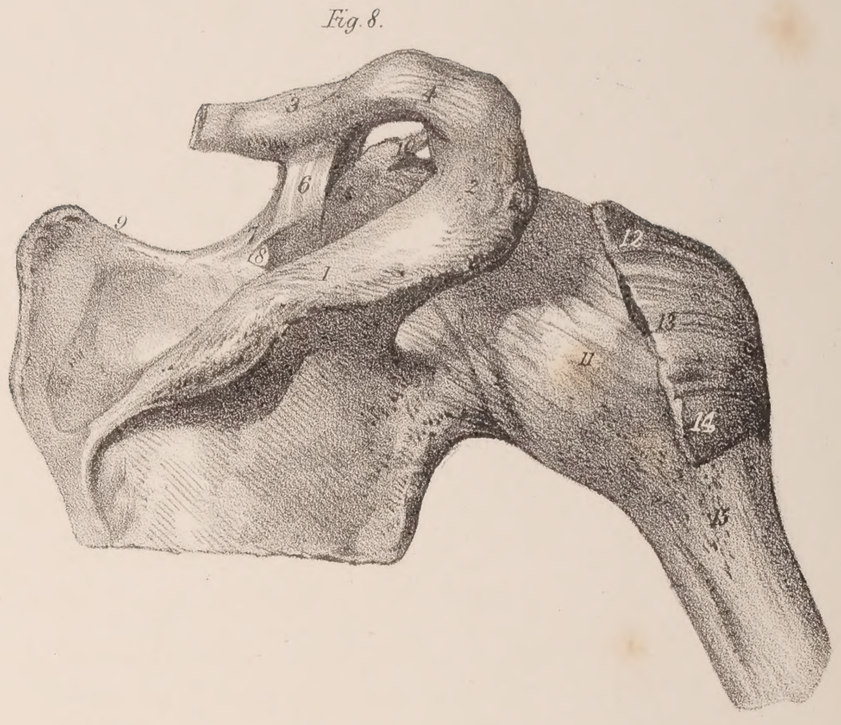


Fig. 1.

Fig. 3.

Fig. 4

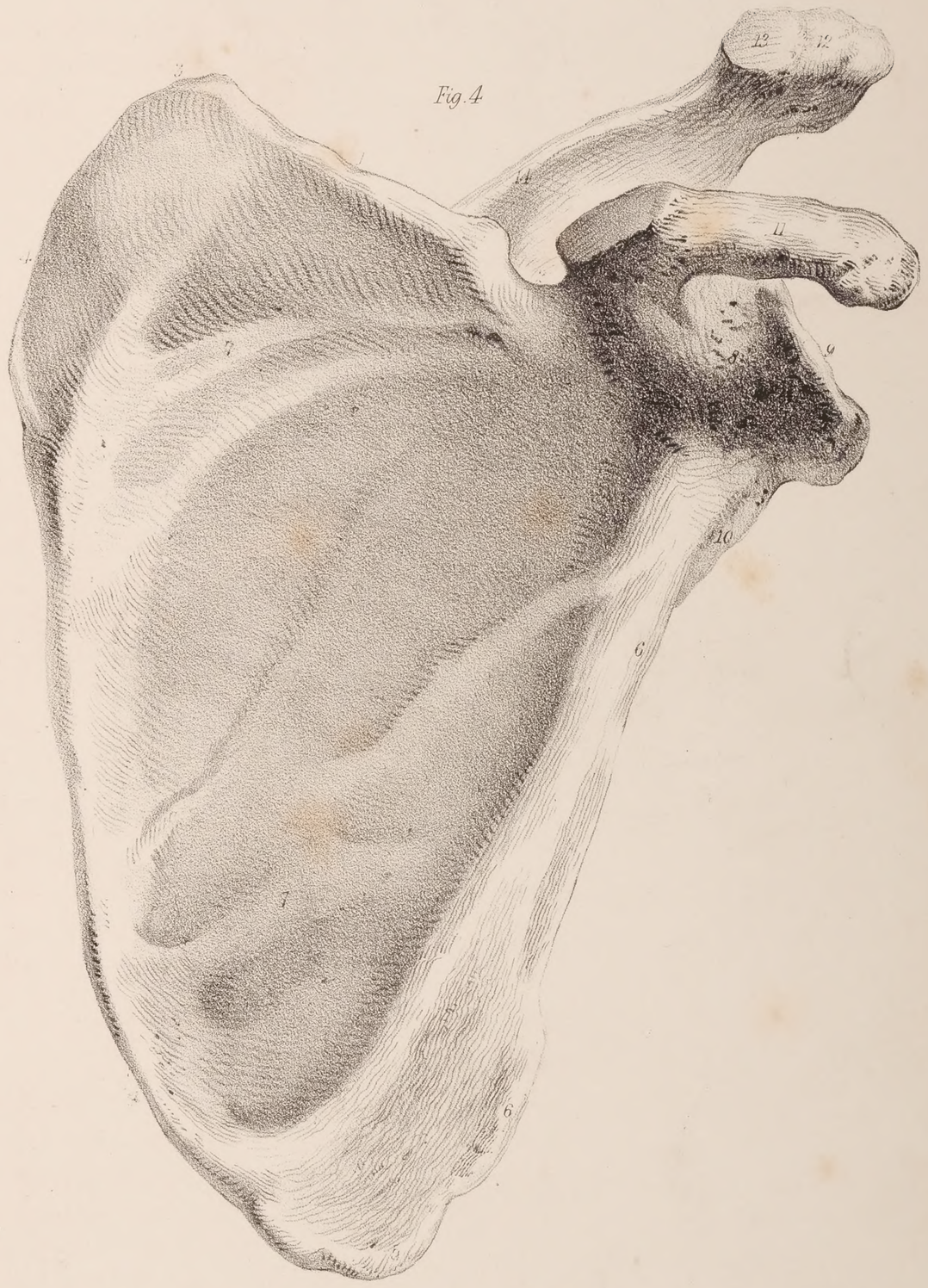
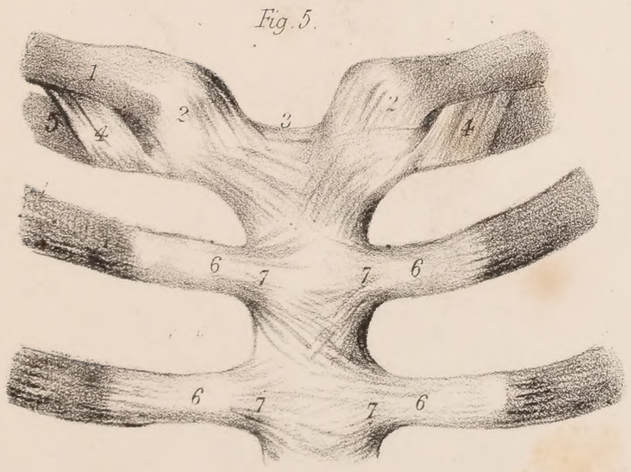


Fig. 2.

Fig. 5.



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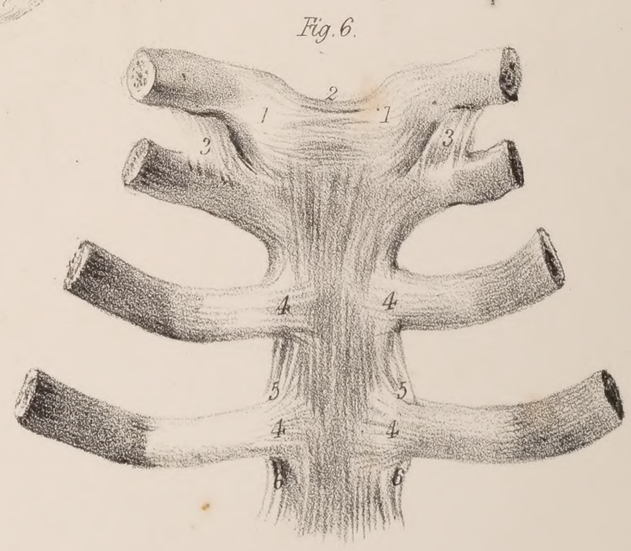
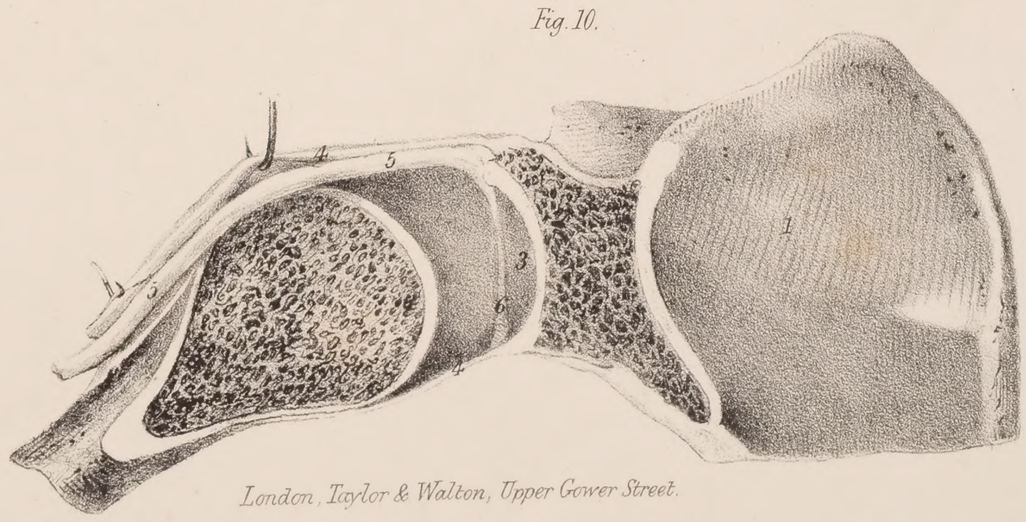


Fig. 10.



Wm. Fairland litho.

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Plate 17.

Fig 1.

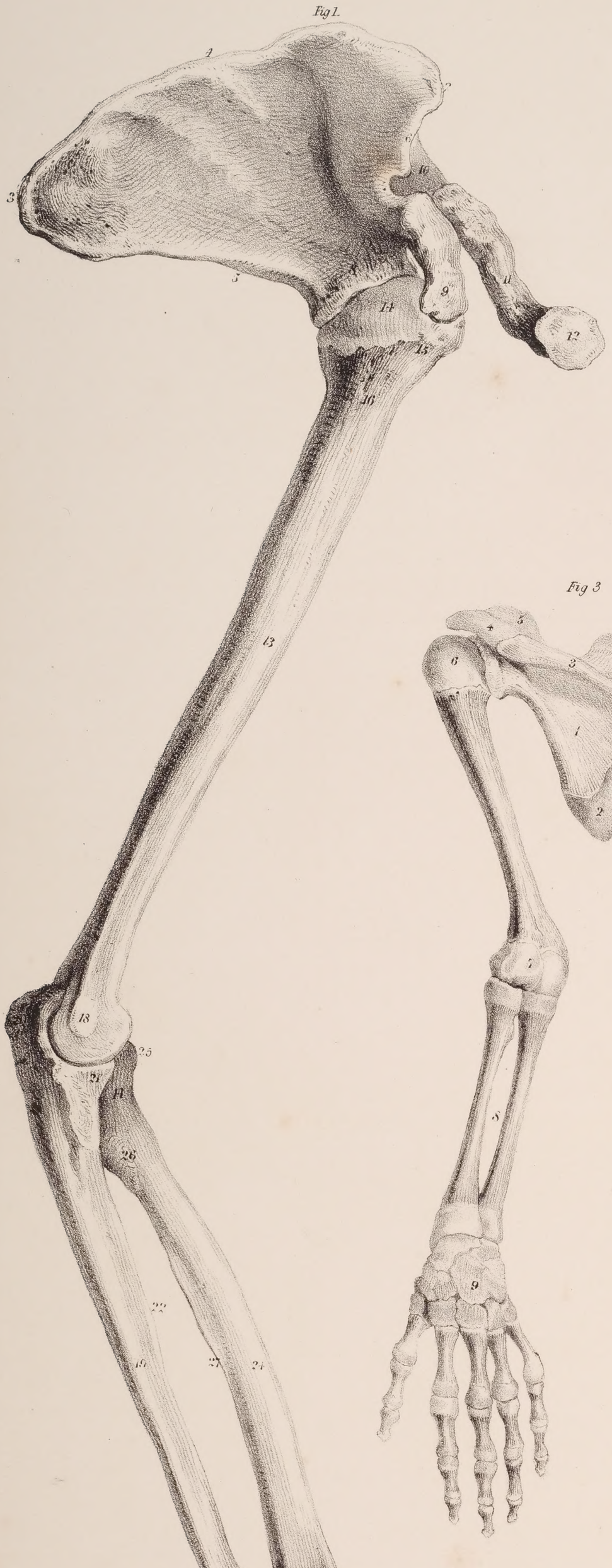


Fig 4.

Fig 2.

Fig 6.

Fig 3

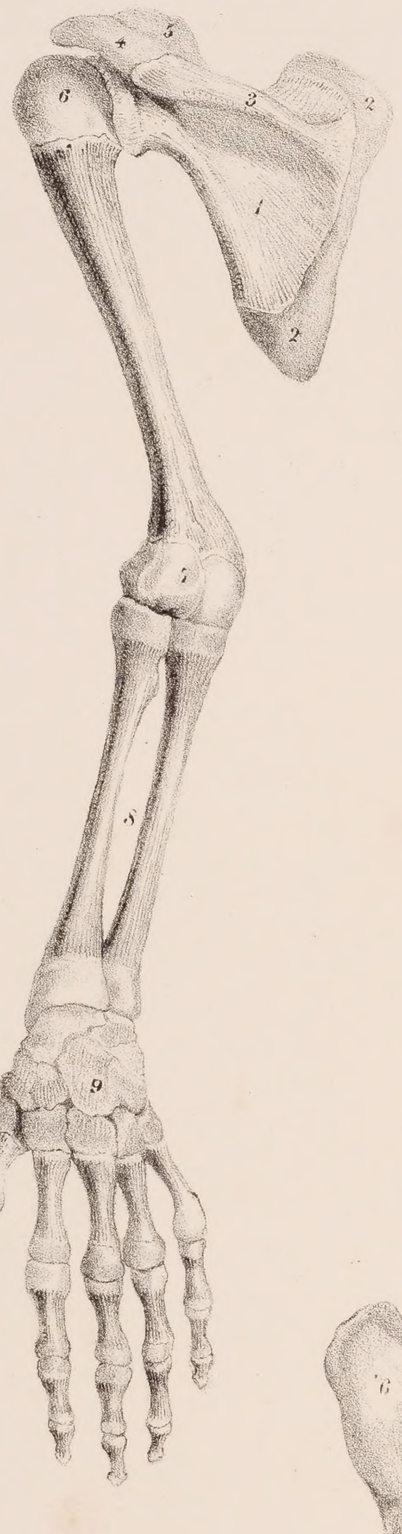
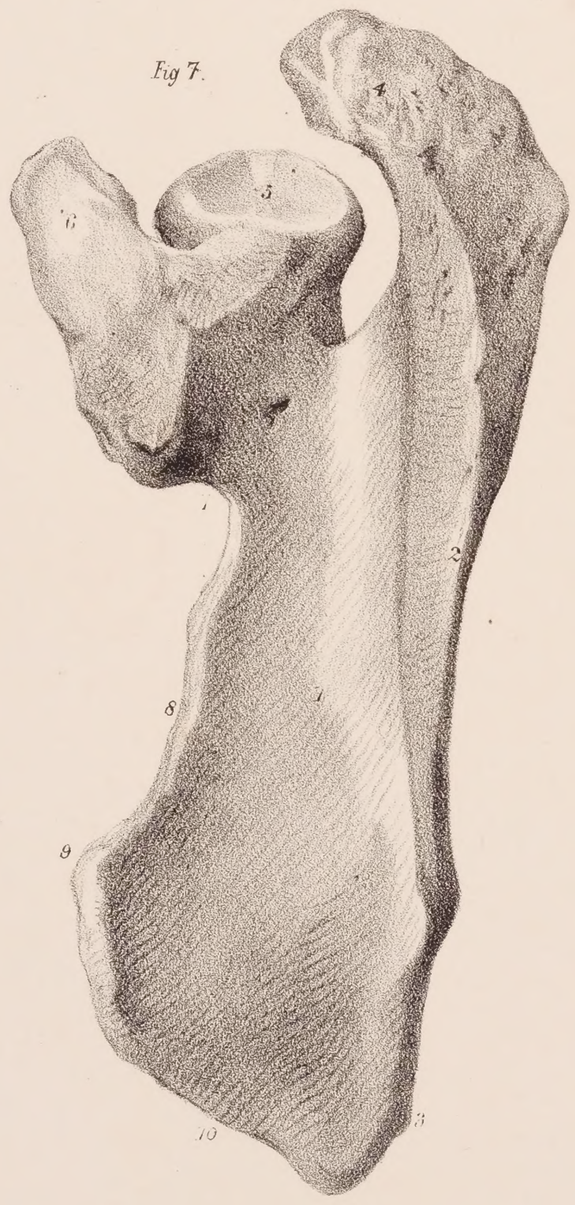


Fig 8.

Fig 7.



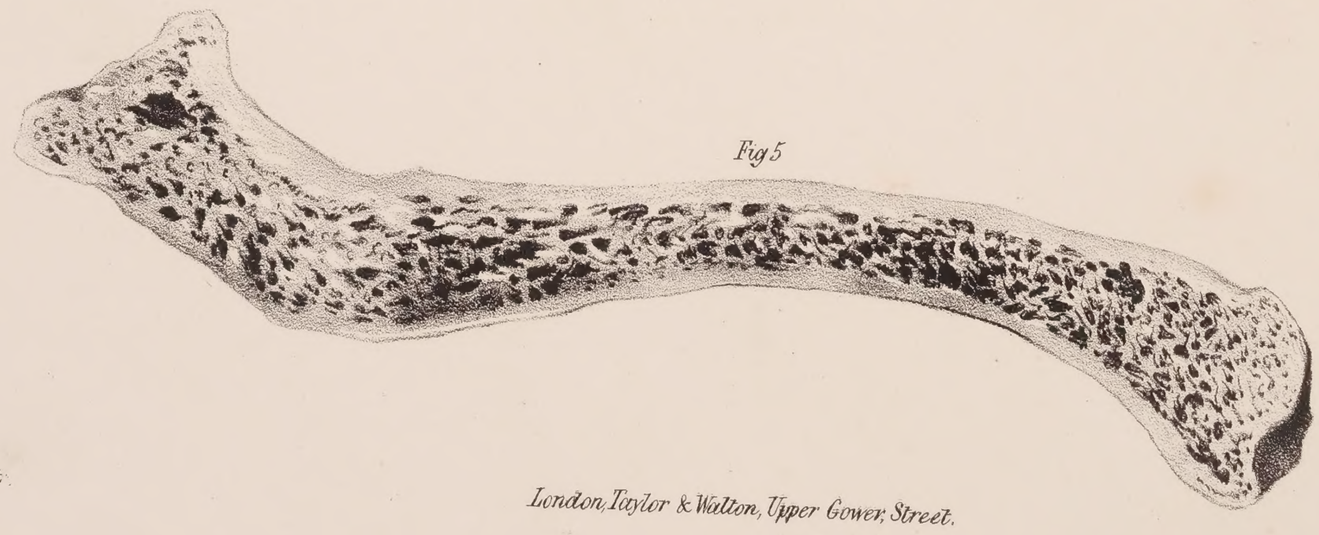


Fig 5

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the ethmoid and os nasi; with the palate bone; with the malar, by the malar eminence; with the os unguis, the vomer, the inferior spongy bone, and the nasal cartilage.

Attachments of muscles.—Proceeding from below upwards;—above the border of the alveolar arch, the buccinator, and the depressor labii superioris alæque nasi; to the canine fossa, the levator anguli oris, and the compressor nasi; to the margin of the orbit, part of the levator labii superioris; to the nasal process, the orbicularis palpebrarum, and the common elevator of the lip and ala of the nose; and just within the orbit, the inferior oblique muscle of the eye.

Developement.—In this case there are several ossific centres,—one in the nasal process, one in the orbital, one in the body, and one or two in the palate process. If the growth be interrupted, the fore

PLATE XVII.

The bones of the upper extremity.

Fig. 1. The bones of the left upper extremity, in their natural relations: after Cheselden.

No. 1. The anterior surface or venter of the scapula. 2. Its superior angle. 3. Its inferior angle. 4. The posterior border of the same bone. 5. Its anterior or inferior border. 6. The superior border. 7. The supra-scapular notch. 8. The neck of the scapula. 9. The coracoid process. 10. A part of the spine of the scapula. 11. The clavicle articulated with the acromion process of the scapula. 12. Its sternal end. 13. The shaft of the humerus. 14. The head of the humerus. 15. Its neck. 16. Its surgical neck. 17. The lesser tuberosity of the humerus. 18. The internal condyle. 19. The shaft of the ulna. 20. The olecranon process. 21. The coronoid process. 22. The interosseous ridge of the ulna. 23. Its styloid process. 24. The radius. 25. Its head. 26. Its tuberosity. 27. Its interosseous ridge. 28. The styloid process of the radius. 29. The scaphoid bone of the carpus. 30. The semi-lunar bone. 31. The cuneiform bone. 32. The pisiform bone. 33. The trapezium. 34. The trapezoides. 35. The os magnum. 36. The unciform bone. 37, 37. The metacarpal bones. 38, 38. The first row of phalanges. 39, 39. The second row of phalanges. 40, 40. The third or last phalanges. 41. The neck of the radius.

Fig. 2. A posterior view of the bones of the left upper extremity, in their natural relations.

No. 1. The dorsum of the scapula; its infra-spinous fossa. 2. The supra-spinous fossa. 3. The spine of the scapula. 4. The smooth surface at the commencement of the spine, over which the tendon of the trapezius muscle plays. 5. The acromion process; articulating, by its extremity, with the clavicle. 6. The clavicle. 7. Its sternal end. 8. The base of the coracoid process. 9. The apex of the coracoid process. 10. The superior border of the scapula. 11. The supra-scapular notch. 12. The superior angle of the bone. 13. Its inferior angle. 14, 14. Its posterior border. 15. Its anterior border. 16. The shaft of the humerus. 17. The rough eminence for the attachment of the tendon of the deltoid muscle. 18. The bicipital groove, upon the head of the bone. 19. The greater tuberosity of the humerus. 20. The lesser tuberosity. 21. The trochlea of the humerus. 22. The internal condyle. 23. The rounded articular surface for articulation with the head of the radius. 24. The external condyle. 25. The depression for the reception of the coronoid process of the ulna, during flexion of the foramen. 26. The radius. 27. The grooves on the posterior surface of the lower extremity of the radius, for the passage of the extensor tendons to the back of the hand. 28. The ulna. 29. Its coronoid process. 30. The lower extremity of the ulna. 31. Its styloid process. 32. The scaphoid bone of the carpus. 33. The semi-lunar bone. 34. The trapezium. 35. The trapezoides. 36. The os magnum. 37. The unciform bone.

Fig. 3. A posterior view of the bones of the left upper extremity of a fœtus: after Cheselden.

No. 1. The scapula. 2, 2. The rim of cartilage which completes the posterior border of the scapula. 3. The spine of the scapula. 4. The acromion process, which is as yet cartilage. 5. The cartilaginous coracoid process. 6. The cartilaginous head of the humerus. 7. The cartilaginous lower extremity of the humerus. 8. The radius and ulna, which are cartilaginous at both extremities. 9. The bones of the carpus, chiefly cartilaginous.

Fig. 4. A fœtal clavicle, cartilaginous at both extremities.

Fig. 5. Section of an adult clavicle, showing its cancellous structure: after Cheselden.

Fig. 6. A scapula, seen upon its anterior and external aspect.

No. 1. The glenoid cavity. 2. The rough surface for the attachment of the long tendon of the biceps. 3. The coracoid process. 4. The spine of the scapula. 5. The acromion process. 6. The dorsal aspect of the bone. 7. Its ventral aspect. 8. The rough surface on the anterior border of the bone, for the attachment of the long head of the triceps. 9. The surface of attachment of the teres minor muscle. 10. The surface of attachment of the teres major. 11. The inferior angle of the bone.

Fig. 7. The scapula, seen upon its superior aspect.

No. 1. The supra-spinous fossa. 2. The spine of the scapula. 3. The smooth surface at the commencement of the spine for the tendon of the trapezius muscle. 4. The acromion process. 5. The glenoid cavity. 6. The coracoid process. 7. The supra-scapular notch. 8. The superior border of the scapula. 9. The superior angle of the bone. 10. A part of the posterior border.

Fig. 8. A fœtal scapula, showing the process of ossification: after Cheselden.

No. 1. The venter of the scapula. 2, 2. The rim of cartilage forming its posterior border and inferior angle. 3. The acromion process. 4. The coracoid process, osseous in the centre, cartilaginous at both extremities. 5. The cartilaginous head of the scapula.

part of the alveolar border with a portion of the palatal arch may remain separate from the rest of the bone, and represent an inter-maxillary bone.

The Malar Bone.—The malar bone (os malæ), common to the face and orbit, forms the most prominent point of the side of the former, and the greater part of the outer border of the latter. Its form is quadrangular. The facial or anterior surface, pierced by some foramina for small vessels, is convex, and gives attachment to the zygomatic muscles;—the posterior overlays the zygomatic fossa, and is rough at its fore part for its articulation with the superior maxillary bone. The superior surface, smooth, narrow, and lunated, extends into the orbit, and articulates with the frontal, sphenoid, and superior maxillary bones.

The superior border forms the outer margin of the orbit; the inferior is on a line with the zygomatic arch, which it contributes to form; the anterior articulates with the maxillary bone; the posterior, curved, gives attachment to the temporal aponeurosis.

Articulations.—It articulates with the frontal, superior maxillary, temporal, and sphenoid bones.

Attachments of muscles.—The zygomatici, to its anterior surface; the masseter, to its inferior border; to its anterior angle, part of the levator labii superioris.

Developement.—It grows from a single ossific point.

The Nasal Bones.—The nasal bones (ossa nasi), situated beneath the frontal bone, and between the ascending processes of the superior maxillary, are small, and irregularly quadrilateral, and form what is called the "bridge" of the nose. They are thick and narrow in their upper part, but gradually become wider and thinner lower down. The anterior surface of each, concave from above downwards, convex from side to side, presents a minute vascular foramen; the posterior, or nasal, is marked by the passage of a branch of the nasal nerve; the superior border articulates with the frontal bone; the inferior with the nasal cartilage; the external with the ascending process of the maxillary bone; the internal with its fellow of the opposite side, and is supported by the nasal spine of the frontal bone, and the perpendicular plate of the ethmoid.

They give attachment to the pyramidales and compressores nasi; and are developed each from a single osseous centre.

Os Unguis—Os Lachrymale.—This small bone is named "ungual" from a resemblance, if not in form, at least in thinness and size, to a finger-nail (unguis); it is also called the "lachrymal" bone, from its presenting a groove which, with a similar excavation in the nasal process of the superior maxilla, forms the lachrymal groove. Placed at the inner and anterior part of the orbit, it presents two surfaces and four borders; its external or orbital surface, plain in the greater part of its extent, is hollowed anteriorly by a groove which runs from above downwards, and contributes, as above stated, to lodge the lachrymal sac. Part of the internal surface, which is rough, corresponds with the anterior ethmoidal cells, the rest with the middle meatus narium. The superior border is articulated with the orbital process of the frontal bone; the inferior with the superior maxillary bone; and where it dips down, to form a part of the lachrymal canal, it joins the inferior spongy bone; anteriorly, it rests on the nasal processes of the superior maxillary bone, and posteriorly on the os planum of the ethmoid.

It is developed from one osseous centre.

The Palate Bone.—The palate bone, (os palati,) wedged in between the superior maxillary and sphenoid bones, is common to the cavity of the mouth, nares, and orbit. In its form this bone somewhat resembles that of the letter L, one part being horizontal, the other vertical.

The horizontal or *palate* plate of the bone, which is nearly square, and forms the back part of the roof of the mouth and of the floor of the nares, articulates anteriorly with the palate plate of the maxillary bone; internally, it presents a rough thick border which rises up into a ridge, which joins with its fellow of the opposite side, and with it forms a groove which receives the lower border of the vomer; externally it unites at right angles with the vertical portion of the bone; posteriorly it presents a thin free border, forming the limit of the hard palate, and giving attachment to the velum or soft palate which projects downwards from it; it is slightly concave, and has at the inner angle a pointed process (*the palate spine*). The superior surface of this plate or process is smooth, and forms the back part of the floor of the nasal cavity: the inferior, which forms part of the roof of the mouth, is unequal, and marked by a transverse ridge, into which the tendinous fibres of the circumflexus palati muscle are inserted; it presents also an oval foramen, being the inferior termination of the posterior palatine canal, which transmits the large descending palatine nerve and accompanying vessels; and farther back, another of smaller size, which transmits the middle palatine nerve.

At the junction of the horizontal and vertical portions, is situated a thick, rough tubercle, (*tube-*

rosity, pyramidal process,) projecting downwards and backwards. This is marked by three vertical grooves; the two lateral ones are rough, and receive the inferior borders of the pterygoid plates of the sphenoid bone; the middle one, smooth, corresponds with and completes the fossa between the pterygoid plates.

The vertical portion of the bone is flat and thin; it presents two surfaces; the internal one (*nasal*) is divided into two parts by a transverse ridge, which articulates with the inferior spongy bone; the space below the ridge forms part of the inferior meatus, that above it of the middle meatus. The external surface, rough and unequal, is divided by a vertical groove, which is completed into a canal (*posterior palatine canal*) by the maxillary bone. The posterior part of this surface articulates with the rough border and nasal surface of the maxillary bone; and the anterior, thin and scaly, with the side of the antrum.

The superior border of the vertical portion of the palate bone presents a notch, forming the greater part of a foramen, which is completed by the sphenoid bone when the parts are in their natural position. This is called the *spheno-palatine* foramen; and outside it is placed the nervous ganglion of the same name (Meckel's ganglion). This notch divides the border of the bone into two processes or heads, the sphenoidal and the orbital.

The *sphenoidal* process, smaller and not so prominent, presents three surfaces, of which one, internal, looks to the nasal fossa; another, external, forms a small part of the zygomatic fossa; and the third, superior, grooved on its upper surface, articulates with the under surface of the sphenoid bone, and with it forms part of the *pterygo-palatine* canal.

The *orbital* process inclines outwards and forwards, and has five surfaces, two of which are free, and three articulated; of the latter, the internal one rests against the ethmoid bone, and covers some of its cellules; the anterior articulates with the superior maxillary bone; and the posterior (which is hollow) with the sphenoid. Of the non-articular surfaces, one superior, smooth, and oblique, forms a small part of the floor of the orbit; the other, external, looks into the zygomatic fossa.

Articulations.—With the corresponding palate bone; with the maxillary, ethmoid, sphenoid, vomer, and inferior spongy bone.

Muscular attachments.—To its spine, the azygos uvulæ; to the centre groove on its tuberosity, a small part of the internal pterygoid; and to the transverse ridge on the palate plate, the aponeurosis of the circumflexus palati.

Developement.—From the position and complex relations of this bone, its mode of growth is difficult to be determined. It appears at first like a single osseous plate slightly curved, and produced from one centre of ossification.

The Vomer.—The vomer, so called from its resemblance to a ploughshare, is flat, irregularly quadrilateral, and placed vertically between the nasal fossæ, presenting two surfaces and four borders. The lateral surfaces form part of the inner wall of the nasal fossæ; the superior border, thick and deeply grooved, receives the rostrum of the sphenoid bone; the margins of the groove expand and are articulated with two small lamellæ at the roots of the pterygoid processes of the sphenoid bone. The anterior border, also grooved, presents two portions, into one of which is implanted the descending plate of the ethmoid, and into the other the nasal cartilage. The posterior border, dividing the posterior nares, is thin and unattached: the inferior is received into the fissure formed by the palate plates of the superior maxillary and palate bones. It is developed from a single osseous centre.

The Inferior Turbinate Bone.—The *inferior turbinate*, or *spongy bone*, (so called from its texture in the latter case, in the former from some resemblance to the lateral half of an elongated bivalve shell,) extends from before backwards, along the side of the nasal fossa:—it appears as if appended to the side of the superior maxillary and palate bones. It is slightly convoluted, and presents an internal convex surface, projecting into the nasal fossa; and an external concave one, which arches over the inferior meatus. Its superior border articulates with the ascending process of the maxillary bone before, with the palate bone behind, and in the centre with the os unguis; it presents also a hooked process, which curves downwards and articulates with the side of the antrum; the inferior border is free, slightly twisted, and dependent. It has one point of ossification.

The Inferior Maxillary Bone.—The inferior maxilla (os maxillæ inferior) is of considerable size, and forms a large portion of the sides and fore part of the face. It is convex in its general outline, and shaped somewhat like a horse-shoe. It is usually considered as divisible into a middle larger portion—its body, and two branches or rami. The *body* is placed horizontally; its external surface is convex, and marked at the middle by a vertical line, indicating the original

division of the bone into two lateral parts, and thence named its *symphysis*. On each side of the symphysis, and just below the incisor teeth, is a superficial depression (the *incisor fossa*), which gives origin to the levator menti muscle; and, more externally, a foramen (*foramen mentale*), which transmits the terminal branches of the dental nerve and artery. A raised line may be observed to extend obliquely upwards and outwards from near the symphysis to the anterior border of the ramus; it is named the *external oblique* line, and is intended to give attachment to muscles. The internal surface of the body of the bone is concave in its general outline, and marked at its centre by a depression corresponding with the symphysis; at each side of which are two prominent tubercles placed in pairs, one above the other, and affording attachment, — the upper pair to the genio-hyo-glossi, and the lower to the genio-hyoidei muscles; beneath these are two slight depressions for the digastric muscles. An oblique prominent line (the *mylo-hyoidean ridge*) will be observed leading from the lower margin upwards and outwards to the ramus; above the line is a smooth depression for the sublingual gland, and beneath it, but situated more externally, is another for the submaxillary gland. The superior border of the body is horizontal, and marked by notches, corresponding with the alveoli, or sockets of the teeth. The inferior border, thicker at its anterior than at its posterior part, is slightly everted, so as to project somewhat forwards.

The branches (*rami*) project upwards from the posterior extremity of the body of the bone, with which they form nearly a right angle in the adult, an obtuse one in infancy, — the "angle" of the jaw. They are thinner somewhat, and appear as if compressed. The external surface of each ramus is flat, and marked by slight inequalities; the internal surface presents at its middle a foramen (*inferior dental*), leading into a canal (dental) contained within the bone, and lodging the dental nerve and vessels. Beneath the foramen, a slight groove marks the passage of some vessels and a nerve, the rest of the surface being rough, for the insertion of the pterygoideus internus. The anterior border of each ramus is nearly vertical in its direction, and terminates

PLATE XVIII.

Anatomy of the humerus.

Fig. 1. An anterior view of the humerus of the right arm: after Cheselden.

No. 1. The shaft of the humerus. 2. The rough surface upon its outer side, which gives attachment to the tendon of the deltoid muscle. 3. The head of the bone. 4, 4. Its neck. 5. The greater tuberosity. 6. The lesser tuberosity. 7, 7. The bicipital groove. 8. The surgical neck of the bone. 9. The anterior bicipital ridge. 10. The posterior bicipital ridge. 11. The lower extremity of the bone. 12. The pulley-like surface which articulates with the ulna. 13. The rounded articular surface for the articulation of the head of the radius. 14. The external condyle. 15. The external condyloid ridge. 16. The internal condyle. 17. The internal condyloid ridge. 18. The fossa which receives the coronoid process of the ulna during flexion of the arm.

Fig. 2. A posterior view of the humerus of the right arm: after Cheselden.

No. 1. The shaft of the bone. 2. The prominence which corresponds with the insertion of the deltoid muscle. 3, 3. The musculo-spiral groove. 4. The head of the bone. 5, 5. Its neck. 6. The greater tuberosity; the number rests upon the surface for the attachment of the infra-spinatus muscle. 7. The surface for the attachment of the teres minor. 8. The surgical neck of the bone. 9. The lower extremity of the humerus. 10. The pulley-like surface for the articulation of the ulna. 11. The external condyle. 12. The external condyloid ridge. 13. The internal condyle. 14. The internal condyloid ridge. 15. The fossa for the reception of the olecranon process of the ulna.

Fig. 3. Section of the humerus, showing its internal structure: after Cheselden.

No. 1. The head of the bone. 2, 2. The line of junction of the epiphysis of the head with the shaft of the bone. 3. The greater tuberosity. 4, 4. The medullary canal of the bone. 5, 5. The solid walls of the bone. 6. The bottom of the fossa for the reception of the olecranon. 7. The external condyle. 8. The internal condyle. 9. The articular surface of the lower extremity of the bone.

Fig. 4. The head of the humerus, seen upon the superior aspect of the bone.

No. 1. The head. 2, 2. A part of the neck. 3. The greater tuberosity; the number rests upon that surface which gives attachment to the tendon of the infra-spinatus muscle. 4. The surface for the attachment of the supra-spinatus. 5. The surface for the attachment of the teres minor muscle. 6. The lesser tuberosity of the humerus. 7. The bicipital groove.

Fig. 5. The lower extremity of the humerus.

No. 1. The trochlear surface for the articulation of the greater sigmoid notch of the ulna. 2. The round articular surface for the head of the radius. 3. The ridge dividing these articular surfaces. 4. The external condyle. 5. The internal condyle. 6. The fossa for the reception of the olecranon process of the ulna.

Fig. 6. An anterior view of the humerus of the right arm of a fœtus.

No. 1. Its shaft. 2. Its cartilaginous head and upper extremity. 3. The cartilaginous lower extremity.

Plate 18.

Fig 1

Fig 3.

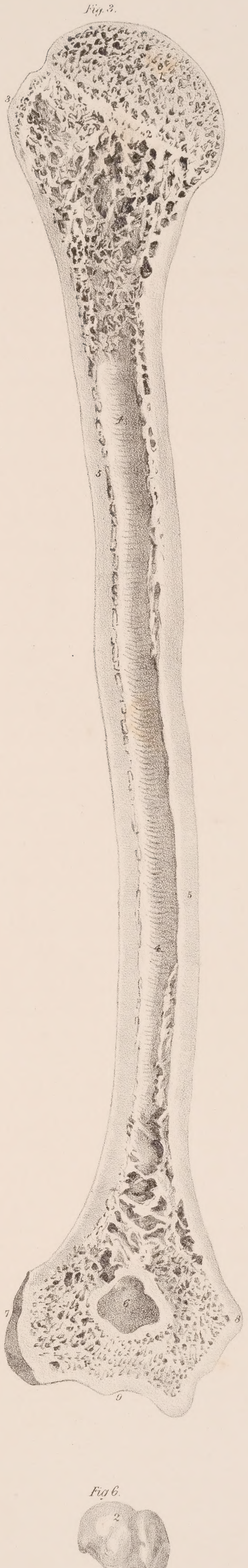

Fig 2

Fig 6.

Fig 4.

Fig 5.

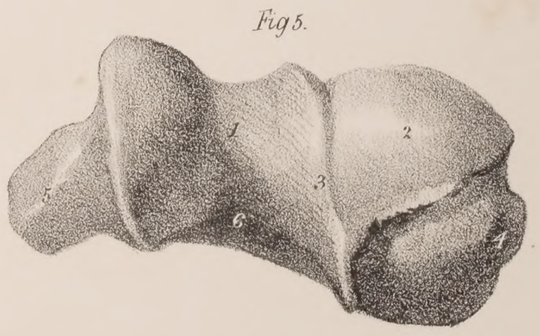

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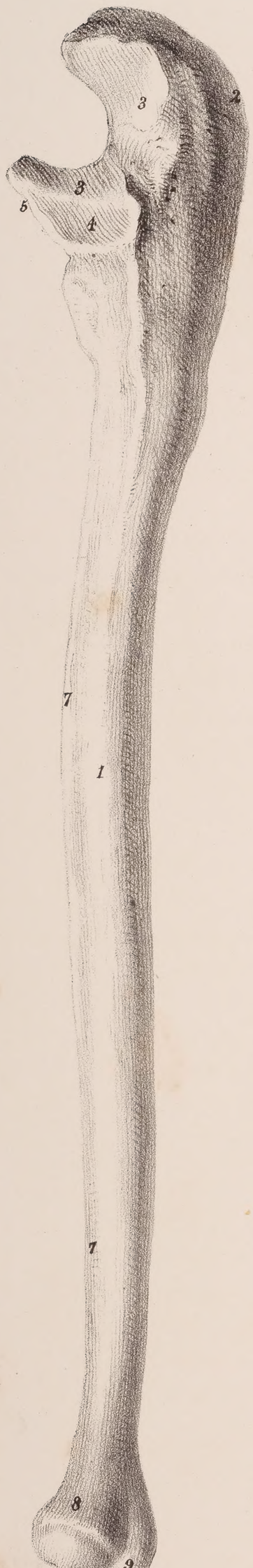
Plate 19.

Fig 2.



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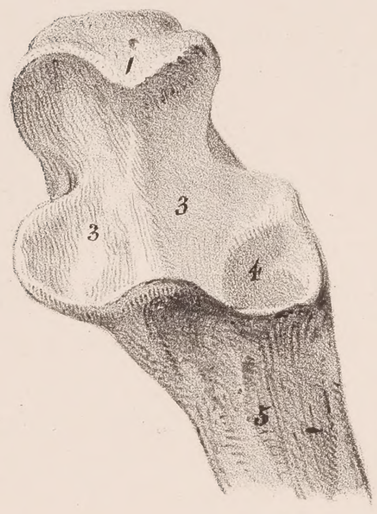


Fig 4.

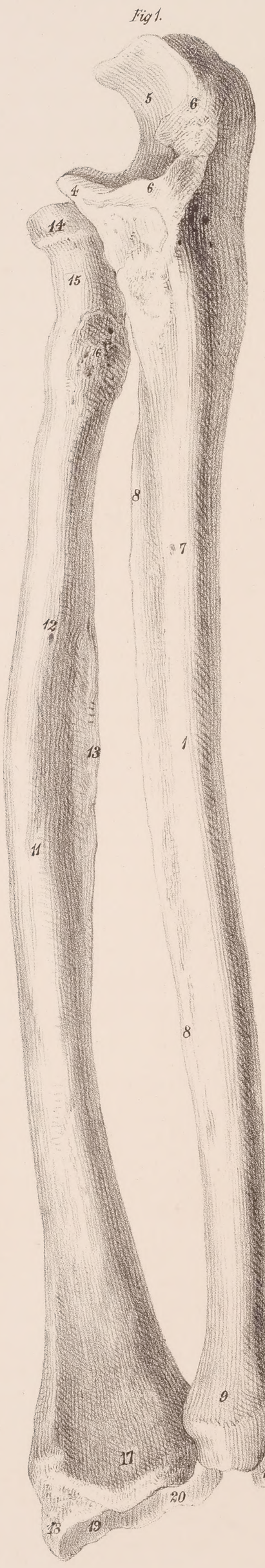
Fig 5.

Fig 6.

Fig 7.

Fig 8.

Fig 1.



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in a pointed extremity, named the *coronoid process;* it is grooved at its commencement, for the attachment of the buccinator muscle. The posterior border is also almost vertical in adults; but in children and edentulous subjects it departs considerably from this direction, and approaches that of the base of the bone. This border is surmounted by a constricted part, which appears as if compressed from before backwards, and is called the *neck* of the bone. It is slightly depressed at its fore part, and gives insertion to the external pterygoid muscle. Now the neck supports the articular head of the bone, (the *condyle,*) which is convex and oblong, its greatest diameter being from without, inwards; the direction of its axis is oblique, so that, if prolonged, it would meet with that of its fellow of the opposite side at the anterior margin of the foramen magnum. The interval between the condyle and the coronoid process, deeply excavated, is called the *sigmoid* notch, and if viewed when the bones are *in situ,* it will be found to form a complete circle with the arch of the zygoma.

Attachments of muscles.—To the incisor fossa, the levator menti; to the external oblique line, the depressor labii inferioris, depressor anguli oris, and a small part of the platysma myoides. To the upper tubercles on the inner surface of the symphysis, the genio-hyo-glossi; to the inferior ones, the genio-hyoidei; to the depression beneath these, the digastricus; to the internal oblique line, the mylo-hyoideus, and posteriorly a small part of the superior constrictor of the pharynx. To the external surface of the ramus, the masseter; to the lower part of the inner surface, the pterygoideus internus; to the neck of the condyle, the pterygoideus externus; to the coronoid process, the temporal.

Developement. — The growth is here effected from two osseous points, one in each lateral half.

Os Hyoides. — This is the υ-shaped bone, so named from some resemblance to the Greek letter υ. It is occasionally called the lingual bone, from its important relations with the tongue; it is situated at the base of the tongue, and may be felt between the chin and the thyroid cartilage. It consists of a body, two cornua, and two cornicula. The body or central piece is small, quadrilateral in its form, and appearing as if compressed from before backwards; hence the direction of its plane is nearly vertical; but the great cornua seem as if compressed from above downwards, so that their plane appears horizontal. The anterior surface of the body is convex, and marked at the middle by a vertical line, on each side of which are depressions for the attachment of

PLATE XIX.

The bones of the fore-arm.

Fig. 1. An anterior view of the bones of the right fore-arm: after Cheselden.

No 1. The shaft of the ulna. 2. The head of the bone. 3. The olecranon process. 4. The coronoid process. 5. The greater sigmoid notch. 6, 6. The rough border to which the broad extremity of the internal lateral ligament is attached. 7. The medullary foramen; upon the shaft of the bone. 8, 8. The interosseous ridge of the ulna. 9. The lower extremity of the bone. 10. Its styloid process. 11. The shaft of the radius. 12. The medullary foramen. 13. The interosseous ridge. 14. The head of the bone. 15. Its neck. 16. The tuberosity into which the tendon of the biceps muscle is inserted. 17. The lower extremity of the bone. 18. Its styloid process. 19. The surface which articulates with the scaphoid bone of the carpus. 20. The surface which articulates with the semilunar bone.

Fig. 2. An ulna of the left arm, viewed upon its external or radial side: after Cheselden.

No. 1. The shaft of the ulna. 2. The olecranon process of the head of the bone. 3, 3. The greater sigmoid notch, for articulation with the trochlea of the humerus. 4. The lesser sigmoid notch, for articulation with the head of the radius. 5. The coronoid process. 6. The surface for the attachment of the anconeus muscle. 7, 7. The interosseous ridge. 8. The inferior extremity of the ulna. 9. Its styloid process.

Fig. 3. A front view of the head of the left ulna.

No. 1. The upper part of the olecranon. 2. The coronoid process. 3, 3. The greater sigmoid notch, for articulation with the humerus. 4. The lesser sigmoid notch, for articulation with the head of the radius. 5. The upper part of the shaft of the bone.

Fig. 4. The head of the ulna, viewed upon its antero-external aspect.

The references are the same as for the preceding figure, with the addition of 6. The surface for the attachment of the anconeus.

Fig. 5. The lower extremity of the ulna, viewed from below.

No. 1. The surface which articulates with the inter-articular fibro-cartilage. 2, 2. The surface which articulates with the lower extremity of the radius. 3. The styloid process of the ulna.

Fig. 6. The head of the radius, viewed from above; and showing the cup-like form of the head of the bone.

Fig. 7. The lower extremity of the radius.

No. 1. Its styloid process.

Fig. 8. The radius and ulna of a fœtus, showing the cartilaginous epiphyses of the bones.

muscles; its posterior surface is concave, and corresponds with the epiglottis. The cornua project backwards, and end in a rounded point. The cornicula, short, irregularly conical in their form, and oblique in their direction, are placed at the junction of the body with the cornua, and give attachment to the stylo-hyoid ligament; they continue for a long time movable, as the cartilage which connects them remains unossified to an advanced period of life.

Attachments of muscles and ligaments. — The stylo-hyoid ligaments, to the cornicula; the thyro-hyoid, to the cornua. The anterior surface gives attachment to the stylo-hyoid, sterno-hyoid, and digastric muscles; the superior border, to the mylo-hyoid, genio-hyoid, genio-hyo-glossi, lingualis, hyo-glossus, and the middle constrictor of the pharynx; its lower border, to the omo-hyoid and thyro-hyoid muscles, and more internally to the thyro-hyoid membrane.

The sutures. — The bones of the skull, and those of the face, are joined together by seams or sutures. The cranial sutures are commonly said to be five in number, of which three are termed true, as the margins of the bones are, in a manner, dove-tailed one into another; and two are called false, or squamous, as they merely overlap one another, like the scales of fishes. The true sutures are, the coronal, the lambdoidal, and the sagittal. These names are obviously ill-chosen; they convey no notion of the position which the sutures occupy in the skull or of the bones which they connect.

The *coronal* suture (sutura coronalis) has been so named from being situated where the ancients wore their garlands (coronæ). It connects the frontal with the two parietal bones, and hence it may with more propriety be called "fronto-parietal." It commences at each side about an inch behind the external orbital process of the frontal bone, where the anterior inferior angle of the parietal articulates with the great wing of the sphenoid bone. From this point it mounts rather obliquely up towards the vertex, having an inclination backwards. The dentations are better marked at the sides than at the summit of the head, for in the latter situation the suture approaches somewhat the squamous character, to allow the frontal bone to overlap the parietal. A similar change takes place at its lower part or commencement, with this difference, that there the parietal bones are made to overlie the frontal.

The *lambdoid* suture (sutura lambdoidalis) is situated between the occipital and the parietal bones, its form resembling somewhat that of the Greek letter Λ, whence its name has been taken. It begins at each side on a line with the posterior inferior angle of the parietal bone, and thence inclines upwards and forwards to the point at which the two parietal bones are joined by the sagittal suture. It thus represents two sides of a triangle. It is often interrupted by accessory osseous deposits (ossa Wormiana). From its position and relation this suture may be named "occipito-parietal."

The *sagittal* suture (s. sagittalis — sagitta, an arrow) extends directly backwards, from the middle of the coronal to that of the lambdoid suture, and connects the two parietal bones, from which circumstance it may be called the "inter-parietal" suture: in children, and occasionally in adults, it is prolonged through the frontal bone, even to the root of the nose. The serrated appearance of the sutures is perceptible only on the external surface of the bones; the internal surface, or table of each, as it is called, being merely in apposition with the contiguous bone.

The line of union between the occipital and the temporal bone at each side used to be considered as a continuation of the lambdoid suture, or as an appendix to it, and was accordingly named *additamentum suturæ lambdoidalis*. It may, however, be named *temporo-occipital*, as it connects the mastoid and petrous parts of the temporal bone with the occipital — principally its basilar and condyloid portions. In this suture there are no regular dentations; in a great part of its extent the margins of the bones are merely in apposition.

The *squamous* sutures (suturæ squamosæ) are arched, and mark the junction of the lower borders of the parietal bones with the squamous parts of the temporal, their edges being so bevelled off as to allow the latter to overlie the former. At the point of junction between the squamous and mastoid parts of the temporal bone, the true squamous suture ceases; but from thence a short suture runs backwards to the lambdoid, connecting the mastoid part of the temporal with the postero-inferior angle of the parietal. This is termed *additamentum suturæ squamosæ:* — both together form the "temporo-parietal" suture.

The line of direction of the sutures (particularly the lambdoid and sagittal) is not unfrequently interrupted by additional bones, inserted between those hitherto enumerated. These, from being sometimes of a triangular form, are called *ossa triquetra*, and also *ossa Wormiana*.

The cranial bones are joined to those of the face by sutures, which are common to both sets

of bones. The *transverse* suture, observable at the root of the nose, extends across the orbits, and connects the frontal with the nasal, superior maxillary, ossa unguis, ethmoid, sphenoid, and malar bones. The *zygomatic* sutures are very short; they are directed obliquely downwards and backwards, and join the zygomatic processes of the temporal with the malar bones. The *ethmoid* suture surrounds the bone of the same name; so does the *sphenoid;* they are necessarily complex in consequence of the many relations of these bones. The lines of connexion between the nasal and maxillary bones, though sufficiently marked, have not received particular names; but those observable between the horizontal lamellæ of the latter, and those of the palate bones, may be termed the palato-maxillary sutures.

Remarks on the general conformation of the Skull. — After having described, in detail, the separate bones of the head and face, it becomes necessary to review them collectively. The description of these bones forms the most difficult part of human, as well as of comparative osteology, as they are the most complex in the whole skeleton; but a correct knowledge of them is indispensable, in consequence of the many important parts which they serve to sustain and enclose; viz. the cerebral mass, with its nerves and vessels; the organs of sight, hearing, smell, and taste; part of those of mastication and deglutition, as well as of voice. To facilitate the description of the numerous eminences, depressions, cavities, and foramina of the skull, anatomists examine successively its external and internal surface: the former may be considered as divisible into five regions, three being somewhat of an oval figure, and situated, one superiorly, another at the base, the third in front, including the face; the others comprise the lateral parts, and are somewhat flat and triangular.

The *superior region* extends from the frontal eminences to the occipital protuberance, and, transversely, from one temporal ridge to the other; it thus includes the upper broad part of the frontal, almost all the parietal, and the superior third of the occipital bone, which together form the vaulted arch of the skull. It is divided into two symmetrical parts by the sagittal suture and its continuation when it exists; it presents no aperture or other inequality deserving of particular notice; it is covered by the common integument and occipito-frontalis muscle, on which ramify branches of the temporal, occipital, and auricular arteries, as well as filaments of nerves from the frontal branches of the fifth and portio dura, and also from the occipital nerve.

The *inferior region*, also oval in its outline, is the most complex of all, as it includes the entire base of the skull, extending from the incisor teeth to the occipital protuberance, and, transversely, from the mastoid process and dental arch on one side, to the corresponding points on the other. It may be considered as divisible into three parts. Of these, one corresponds with the extent of the arch of the palate; it is divided into two parts, by a line extending from before backwards, and marking the junction of the palate processes of the superior maxillary and palate bones; this is intersected by another, running transversely between each palate bone and the corresponding maxillary bone. Anteriorly, and in the middle line, is a foramen, (the *anterior palatine,*) which in the floor of the nares is double, but becomes single inferiorly, and transmits the naso-palatine nerve; posteriorly, on each side, and at the base of the alveolar border, is another foramen, (*posterior palatine,*) for the posterior palatine nerves and artery. The middle, or guttural region, is bounded at each side by a line extended from the pterygoid process as far as the mastoid process, thus including the posterior aperture of the nares, and the central part of the base of the skull. In the centre is situated the basilar process of the occipital bone, marked by slight inequalities for the attachment of muscles, and towards its posterior extremity the anterior condyloid foramina, which transmit the ninth pair of nerves. On each side is the pars petrosa of the temporal bone, in which may be observed the styloid and vaginal processes; more posteriorly is the jugular fossa, which is completed into a foramen (*foramen lacerum posterius basis cranii*) by the border of the occipital bone. This is divided into two parts by a spicula of bone, or a fibrous band, the internal and anterior one serving to transmit the glosso-pharyngeal, par vagum, and spinal accessory nerves; the other the jugular vein. Between the apex of the pars petrosa, and the side of the basilar process, and the body of the sphenoid bone, is the *foramen lacerum anterius basis cranii,* which is closed inferiorly by a thin plate of cartilage: across its area, as viewed at its upper or cerebral aspect, runs the internal carotid artery in its passage from the carotid canal in the temporal bone to the side of the sphenoid, and also the Vidian nerve, after it has passed backwards through the pterygoid foramen, and is proceeding to reach the groove in the upper surface of the pars petrosa. Between the contiguous margins of the pars petrosa and the great ala of the sphenoid bone is a groove, which leads backwards and outwards, and lodges the cartilaginous part of the Eustachian tube; and above the osseous part of that tube, and separated from it by a thin

lamella of bone, is the orifice of the canal which transmits the tensor tympani muscle. The foramina of this region, taken in their order, from within outwards and backwards, are, the foramen ovale, foramen spinosum, foramen caroticum, and stylo-mastoideum.

The anterior part of this region is continuous with the posterior aperture of the nares, which is divided into two parts by the vomer. It is bounded above by the body of the sphenoid bone, below by the palate plates of the ossa palati, and on the sides by the pterygoid processes. The pterygoid groove, in each of these processes, is completed inferiorly by the pyramidal process of the palate bone; near its junction with the body of the bone is the scaphoid fossa, for the origin of the circumflexus palati; and at its inferior termination is the hamular process, round which the tendon of that muscle is reflected. Between the base of this process and the posterior palatine foramen is situated a smaller foramen, leading down from the posterior palatine canal, and which transmits the middle palatine nerve.

The posterior part of the inferior region includes all that is situated between the occipital protuberance and a line connecting the mastoid processes. It is divided into two lateral parts by a ridge, extending to the foramen magnum from the occipital protuberance, from which two rough curved lines branch outwards, giving attachment to muscles; so does the space between the lines, and that between the inferior one and the foramen magnum. At the margin of the foramen, but nearer to its anterior termination, are the condyles of the occipital bone which articulate with the first vertebra; behind each is a depression (*condyloid fossa*), and usually a foramen (*posterior condyloid foramen*), which transmits a small vein and artery. Before and a little to the outer side of each, in a spot also retiring and depressed, is the opening of the *anterior condyloid foramen*, which looks obliquely outwards and forwards, and transmits the lingual nerve.

The *anterior region* of the skull is of an oval form, and extends from the frontal eminences to the

PLATE XX.

The bones of the wrist and hand.

Fig. 1. A front view of the right wrist and hand: after Cheselden.

No. 1. The scaphoid bone. 2. The semilunar bone. 3. The cuneiform bone. 4. The pisiform bone. 5. The os trapezium. 6. The os trapezoides. 7. The os magnum. 8. The unciform bone. 9. Its hook-like process. 10. The metacarpal bone of the thumb. 11. The metacarpal bone of the index finger. 12. Its broad base, articulating with three bones of the carpus; the rough surface immediately below the figure is for the insertion of the tendon of the flexor carpi radialis. 13. The metacarpal bone of the middle finger. 14. The metacarpal bone of the ring finger with its small base. 15. The metacarpal bone of the little finger. 16. The first phalanx of the thumb. 17, 17. The first phalanges of the four fingers. 18, 18. The second phalanges of the fingers. 19, 19. The last phalanges of the fingers. 20. The last phalanx of the thumb.

Fig. 2. A posterior view of the right wrist and hand: after Cheselden.

No. 1. The scaphoid bone. 2. The semilunar bone. 3. The cuneiform bone. 4. The os trapezium. 5. The os trapezoides. 6. The os magnum. 7. Its rounded head. 8. The unciform bone. 9. The metacarpal bone of the thumb, articulating with the os trapezium. 10. The metacarpal bone of the index finger, articulating with the os trapezium, os trapezoides, and os magnum. 11. The depression for the insertion of the tendon of the extensor carpi radialis longior. 12. The metacarpal bone of the middle finger, articulating with the os magnum only. 13. The depression for the insertion of the tendon of the extensor carpi radialis brevior. 14. The metacarpal bone of the ring finger. 15. The metacarpal bone of the little finger, articulating with the os unciforme. 16. The depression of insertion for the tendon of the extensor carpi ulnaris. The other numbers of reference are the same as in the preceding figure.

Fig. 3. The bones of the carpus; showing the surfaces of the second row, which articulate with the metacarpal bones: after Cheselden.

No. 1. The surface of the os trapezium, which articulates with the metacarpal bone of the thumb. 2. The process on the palmar surface of the os trapezium, which overhangs the groove for the tendon of the flexor carpi radialis. 3. The os trapezoides. 4. The os magnum. 5. Its rounded head. 6. The unciform bone. 7. Its hook-like process. 8. The scaphoid bone. 9. The semilunar bone. 10. The cuneiform bone. 11. The pisiform bone.

Fig. 4. Separate bones of the carpus.

No. 1. The scaphoid bone. 2. Its concave surface. 3. Its broad extremity. 4. Its pointed extremity or tuberosity. 5. The semilunar bone. 6. The concave articular surface of the bone. 7. Its convex articular surface. 8. Its palmar extremity. 9. The cuneiform bone. 10. Its broad extremity. 11. Its apex. 12. The pisiform bone. 13. Its articular facet. 14. The os trapezium, viewed upon its dorsal aspect. 15. The surface which articulates with the metacarpal bone of the thumb. 16. The os trapezoides. 17. The os magnum. 18. Its rounded head. 19. Its dorsal surface. 20. The surface which articulates with the middle metacarpal bone. 21. The unciform bone. 22. Its hook-like process.

Fig. 5. The hand and wrist of the fœtus: after Cheselden.

The carpus is wholly cartilaginous, as are the extremities of the metacarpal bones and phalanges.

Fig. 6. A sesamoid bone, viewed upon its convex and upon its articular surface.

Plate 20.

Fig 1.

Fig 4.

Fig 5.

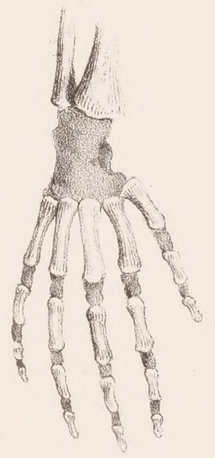

Fig 3.

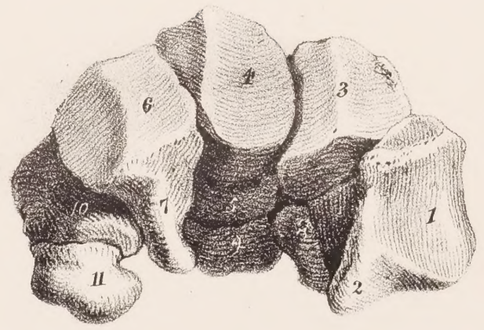

Fig 6.

Fig 2.

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Fig. 1.

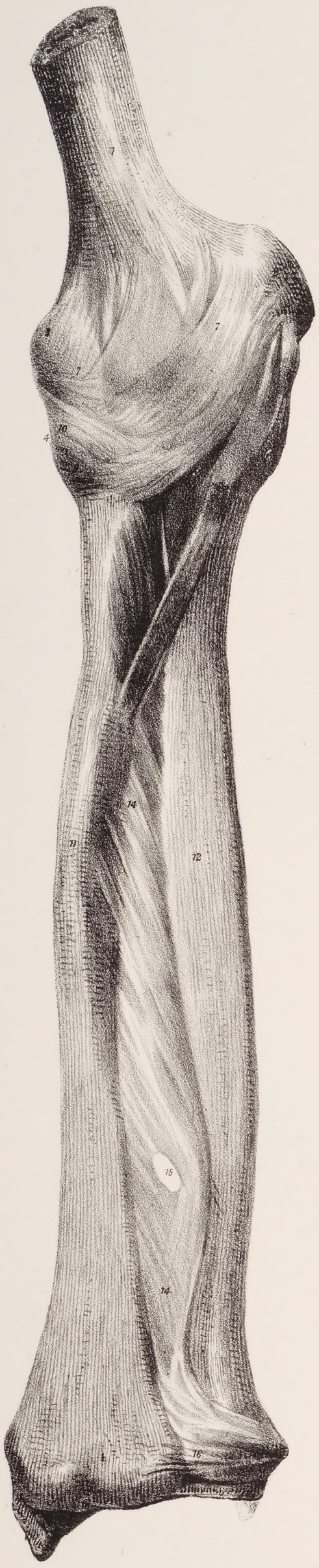


Fig. 3.

Fig. 2.

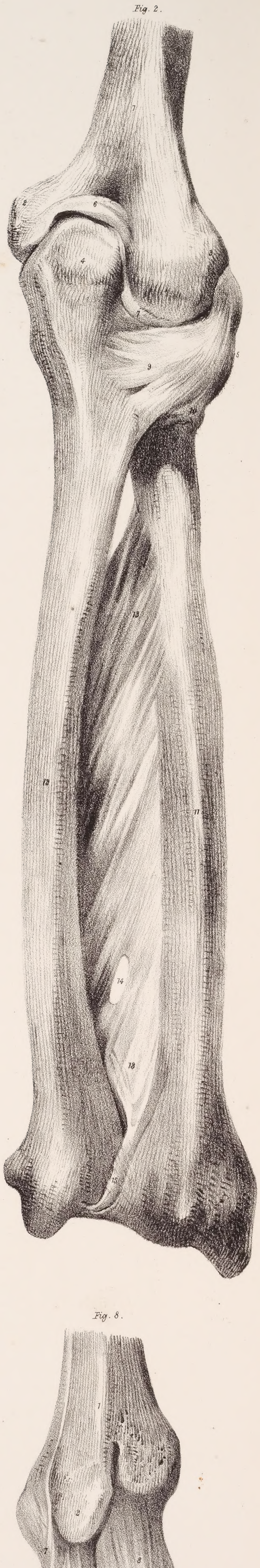


Fig. 4.

Fig. 5.

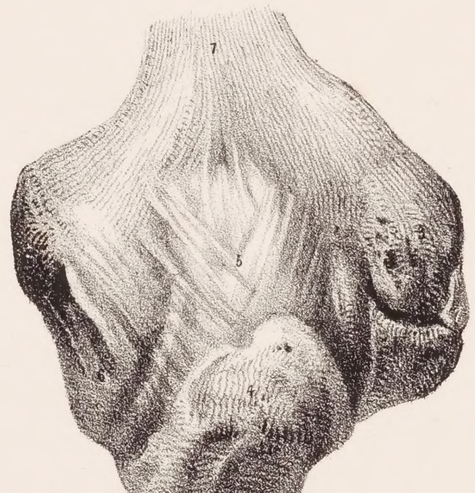
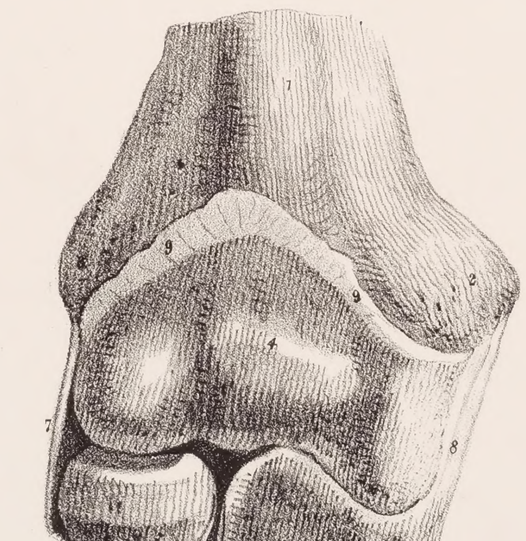


Fig. 7.

Fig. 8.

Fig. 6.



W. Fairland, lith.

London, Taylor & Walton, Upper Gower Street.

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chin, and from the external border of the orbit and ramus of the jaw, on one side, to the corresponding points on the other, so as to include the whole of the face. The eminences, depressions, fossæ, and foramina, observable in this region, are as follow, viz. the frontal eminences, more or less prominent in different individuals, bounded inferiorly by two slight depressions, which separate them from the superciliary ridges; these curve outwards, from the nasal process of the frontal bone. Beneath the superciliary ridge, on each side, is the margin of the orbit, marked at its inner third by a groove, or a foramen, which transmits the frontal nerve and supra-orbital artery; and also by a slight depression, which gives attachment to the cartilaginous pulley of the trochlearis muscle. At an interval corresponding with the breadth of the orbit is another ridge, forming its inferior margin; under which is situated the infra-orbital foramen, for the passage of the superior maxillary nerve; and still lower down, the fossa canina, which gives attachment to the levator anguli oris muscle; it is bounded below by the alveolar border of the upper jaw, and surmounted by the malar tuberosity. Towards the middle line, and corresponding with the interval between the orbits, is the nasal eminence of the frontal bone, which is prominent in proportion to the developement of the frontal sinuses over which it is situated. This is bounded by the transverse suture, marking the root of the nose. Beneath the nasal, and between the contiguous borders of the superior maxillary bones, is a triangular opening which leads into the nasal fossæ; it is broad below, and there its edge is surmounted by a prominent process, the nasal spine. Laterally it presents two sharp curved borders, which gradually incline inwards as they ascend to the nasal bones, so as to narrow it somewhat. Below the nasal aperture is a slight depression (myrtiform fossa), at each side of the middle line over the alveolus of the second incisor tooth. Farther down is the transverse rima of the mouth, between the alveolar borders of the jaws. In the inferior maxillary bone, besides some muscular impressions, is the mental foramen, which transmits the terminal branches of the dental nerve and artery.

The two *lateral* regions of the skull are somewhat of a triangular figure, the apex of the triangle being at the angle of the lower jaw, the base at the temporal ridge, and the sides formed by two lines drawn, one upwards and forwards, over the external orbital process, the other upwards and backwards over the mastoid process. In consequence of the great irregularity of the surface, it is necessary to subdivide each of these regions into three; the part above the zygoma being called the temporal region or fossa, that beneath it the zygomatic, the remainder being named the mastoid.

The *temporal* region, or fossa, being bounded by the temporal ridge above, and by the zygomatic arch below, is of a semicircular form, and extends from the external angular process of the frontal bone to the base of the mastoid process. It is filled up by the temporal muscle, lodges the deep temporal vessels and nerves, and is formed by the temporal, parietal, frontal, sphenoid, and malar bones.

The *mastoid* region is bounded before by the transverse root of the zygoma, above by the horizontal one and the additamentum suturæ squamosæ, behind and inferiorly by the additamentum

PLATE XXI.

The ligaments of the elbow-joint, fore-arm, and wrist-joint.

Fig. 1. The ligaments of the elbow-joint and fore-arm, seen from the front.

No. 1. The lower part of the humerus. 2. The internal condyle. 3. The external condyle. 4. The projection formed by the head of the radius. 5. The coronoid process of the ulna. 6. The border of the greater sigmoid notch. 7, 7. The anterior ligament of the elbow-joint. 8. The internal lateral ligament. 9. The orbicular ligament of the head of the radius. 10. Some few of the anterior fibres of the external lateral ligament passing down to be inserted into the orbicular ligament. 11. The radius. 12. The ulna. 13. The oblique ligament. 14, 14. The interosseous ligament. 15. The opening which transmits the anterior interosseous artery. 16. The anterior ligament of the inferior radio-ulnar articulation. 17. The triangular fibro-cartilage of the inferior radio-ulnar articulation.

Fig. 2. The ligaments of the elbow-joint and fore-arm, seen from behind.

No. 1. The lower extremity of the humerus. 2. The internal condyle. 3. The external condyle. 4. The olecranon process of the ulna. 5. A projection made by the head of the radius. 6. The posterior ligament thrown into folds by the extension of the joint. 7. A part of the posterior ligament. 8. The external lateral ligament of the elbow. 9. Its posterior fibres, which are inserted into the ulna. 10. The orbicular ligament of the superior radio-ulnar articulation. 11. The radius. 12. The ulna. 13, 13. The interosseous ligament. 14. The opening in the interosseous ligament for the passage of the anterior interosseous artery. 15. The posterior ligament of the inferior radio-ulnar articulation.

Fig. 3. Ligaments of the elbow-joint, viewed from the inner side.

No. 1. The lower extremity of the humerus. 2. Its internal condyle. 3. The olecranon. 4. The ulna. 5.

suturæ lambdoidalis. Proceeding from behind forwards, we observe the mastoid foramen, the process of the same name, anterior to which is the aperture of the meatus auditorius externus, which is circular in young subjects and somewhat oval in adults, the greatest diameter being from above downwards. The osseous tube continuous, externally, with the fibro-cartilage of the ear, and bounded, internally, by the membrana tympani, is directed, obliquely, forwards and inwards, and is somewhat broader at its extremities than in the middle. Anterior to the meatus is the glenoid fossa, which is bounded before by the transverse root of the zygoma, behind by the meatus, and internally by the spinous process of the sphenoid bone. It is divided into two parts by a transverse fissure (*fissura Glasseri*), the anterior portion being smooth, for its articulation with the condyle of the lower jaw; the posterior, rough, lodges part of the parotid gland. This fissure gives entrance to the laxator tympani muscle and a small artery, and transmits outwards the chorda tympani nerve.

The *zygomatic* region, situated deeply behind and beneath the orbit, is bounded before by the convex part of the superior maxillary bone, and is enclosed between the zygoma and the pterygoid process. The posterior surface of the maxillary bone is pierced by some small foramina, opening into canals, for the transmission of the superior dental nerves. Between the superior border of this bone, and the great ala of the sphenoid, is a fissure (*spheno-maxillary*), which is directed forwards and outwards, and communicates with the orbit; and between its posterior border and the pterygoid process is another (*pterygo-maxillary*), whose direction is vertical. The angle formed by the union of these fissures constitutes the *spheno-maxillary fossa*, which is situated before the

The radius. 6. The internal lateral ligament of the elbow. 7. Its anterior fibres continued downwards on the coronoid process of the ulna. 8. Its posterior fibres going to be attached to the side of the olecranon. 9. The anterior ligament of the articulation. 10. The orbicular ligament surrounding the head of the radius. 11. The tendon of the biceps curving around the radius to its insertion. 12. The upper part of the interosseous ligament.

Fig. 4. Ligaments of the elbow-joint, viewed from the outer side.

No. 1. The lower extremity of the humerus. 2. The outer condyle. 3. The olecranon process of the ulna. 4. The ulna. 5. The radius. 6. Its tuberosity, seen from behind. 7. The neck of the radius. 8. The external lateral ligament. 9. Its posterior fibres passing backwards to be inserted into the border of the olecranon. 10. The orbicular ligament. 11. The anterior ligament of the joint. 12. The posterior ligament. 13. The interosseous ligament.

Fig. 5. The elbow-joint, flexed, and seen from behind.

No. 1. The lower extremity of the humerus. 2. The internal condyle. 3. The external condyle. 4. The upper part of the olecranon. 5. The posterior ligament of the articulation. 6. The posterior part of the internal lateral ligament. 7. The external lateral ligament.

Fig. 6. The elbow-joint laid open from the front, in order to show the reflections of the synovial membrane.

No. 1. The lower extremity of the humerus. 2. Its internal condyle. 3. Its external condyle. 4. Its articular surface covered with cartilage. 5. The ulna. 6. The radius. 7. The external lateral ligament. 8. The internal lateral ligament. 9, 9. The anterior ligament drawn up. 10. The pouch of synovial membrane which intervenes between the head of the radius and the orbicular ligament. 11. The pouch of synovial membrane which is reflected between the head of the radius and the lesser sigmoid notch of the ulna. 12. The oblique ligament.

Fig. 7. The ligaments of the wrist-joint, viewed from the radial aspect.

No. 1. The lower part of the radius. 2. Grooves for the tendons of the extensor muscles of the thumb and of the wrist. 3. The styloid process of the radius. 4. The external lateral ligament of the wrist-joint. 5. The posterior ligament of the wrist. 6. The anterior ligament. 7, 7. The dorsal ligaments connecting the carpal bones. 8. The small end of the scaphoid bone. 9. The ligament connecting the scaphoid with the trapezium bone. 10. The external border of the trapezium. 11, 11. The palmar ligaments of the carpal bones. 12. The pisiform bone. 13. The unciform bone. 14. The dorsal carpo-metacarpal ligaments. 15. The transverse bands connecting the metacarpal bones with each other. 16. The tendon of the extensor carpi radialis longior cut off close to its insertion. 17. The tendon of the extensor carpi radialis brevior. 18, 18. The capsular carpo-metacarpal ligament of the thumb. 19. The tendon of the extensor ossis metacarpi pollicis divided close to its insertion. 20. Part of the metacarpal bone of the thumb. 21. Part of the metacarpal bone of the fore-finger.

Fig. 8. The ligaments of the wrist-joint, viewed from the ulnar aspect.

No. 1. The lower part of the ulna. 2. Its styloid process. 3. The internal lateral ligament of the wrist-joint. 4. The pisiform bone. 5. The cuneiform bone. 6. The hook-like process of the unciform bone. 7. The anterior ligament of the wrist. 8. The posterior ligament. 9, 9. The dorsal ligaments of the carpal bones. 10. The palmar ligaments of the carpal bones. 11, 11. The dorsal carpo-metacarpal ligaments. 12, 12. Transverse bands connecting the bases of the metacarpal bones. 13. The tendon of the extensor carpi ulnaris, divided close to its insertion. 14, 14. The internal lateral ligaments connecting the two ranges of the carpal bones and the latter with the fifth metacarpal bone. 15. Part of the metacarpal bone of the little finger. 16. Part of the metacarpal bone of the thumb. 17. The capsular carpo-metacarpal ligament of the thumb.

base of the pterygoid process, behind the summit, or posterior termination, of the orbit, and immediately external to the nasal fossæ, from which it is separated by the perpendicular plate of the palate bone. Into this narrow spot five foramina open, viz. the foramen rotundum, which gives passage to the second branch of the fifth pair; the foramen pterygoideum, to the Vidian or pterygoid nerve and artery; the pterygo-palatine, to a small artery of the same name (sometimes called also the superior pharyngeal); the posterior palatine foramen, leading to the canal of the same name; and the spheno-palatine, which transmits the spheno-palatine nerve and artery.

The *internal surface* of the skull may be divided into its arch and its base. The arch extends from the base of the perpendicular part of the frontal bone, as far as the transverse ridge on the inner surface of the occipital bone. Along the middle line, and corresponding with the direction of the sagittal suture, is a shallow groove, marking the course of the superior longitudinal sinus. Several slight irregular depressions may also be observed, for the cerebral convolutions, and some tortuous lines for the branches of the meningeal artery; and in many cases irregular depressions over the points occupied by glandulæ Pacchioni. The surface is more or less depressed so as to form fossæ at the points corresponding with the frontal and parietal eminences, and also above the internal occipital ridge, where the posterior lobes of the brain are lodged.

The *base* of the skull presents the several eminences, depressions, and foramina, which have been already enumerated in the description of the separate bones. Three fossæ may be observed at each side, differing in size and depth.

The *anterior fossa*, formed by the orbital plate of the frontal bone and the smaller wing of the sphenoid, serves to support the anterior lobe of the brain: it is marked by eminences and depressions corresponding with the cerebral convolutions and sulci; and, posteriorly, by a transverse line, indicating the junction of the bones just mentioned.

The *middle fossa*, formed by the great ala of the sphenoid, the squamous part of the temporal, and the anterior surface of the pars petrosa, lodges the middle lobe of the brain. It is marked by linear impressions for the meningeal artery, and by shallow pits for the cerebral convolutions; anteriorly it opens into the orbit by the sphenoidal fissure, sometimes called foramen lacerum anterius to distinguish it from those placed farther back, and already noticed; it transmits the third, the fourth, and the sixth nerves, together with the ophthalmic branch of the fifth and the ophthalmic vein. Behind this is situated the foramen rotundum for the second branch of the fifth, the foramen ovale for the third, and, lastly, the foramen spinosum for the middle meningeal artery. Where the summit of the pars petrosa approaches the body of the sphenoid bone, there the internal orifice of the carotid canal opens. On the anterior surface of the pars petrosa, and directed obliquely backwards, there is a slight groove, leading to the hiatus Fallopii, and transmitting the Vidian nerve.

The *posterior fossa*, deeper and broader than the others, gives lodgment to the lateral lobes of the cerebellum. In the posterior surface of the pars petrosa, which forms the boundary of this fossa, may be observed the internal auditory foramen, and, within a few lines of it, a triangular fissure, which opens into the aquæductus vestibuli, and towards its inferior margin part of the groove for the lateral sinus, which leads down to the foramen lacerum posterius. Along the middle line, and taking the parts situated in the base of the skull from before backwards, we observe the crista galli of the ethmoid bone, and on each side the cribriform lamella of that bone; farther back, a slightly depressed surface, which supports the commissure of the optic nerves; and on each side the optic foramina. Behind this is the pituitary fossa, situated on the body of the sphenoid bone, bounded before and behind by the clinoid processes. Leading downwards and backwards from these is the basilar groove, which supports the pons Varolii and medulla oblongata, and terminates at the foramen magnum: at each side of this foramen are the condyloid foramina, and behind it a crista, leading upwards to the occipital ridge, and giving attachment to the falx cerebelli.

The Orbits.—The form of the orbits is that of a quadrilateral pyramid, whose base is directed forwards and outwards, and apex backwards and inwards, so that if their axes were prolonged backwards they would decussate on the body of the sphenoid bone.

The *roof* of each orbit forms part of the floor for the brain; it is concave, and composed of the orbital process of the frontal, and the smaller wing of the sphenoid bone: at its anterior and inner border may be observed a depression for the attachment of the pulley of the trochlearis muscle; externally, and immediately within the margin of the orbit, a shallow depression for the lachrymal gland; at the anterior border, a groove, sometimes a foramen, which transmits the supra-orbital or frontal nerve and artery; and posteriorly, at the apex of the cavity, the optic

foramen, transmitting the optic nerve and ophthalmic artery. The *floor* forms the roof of the maxillary sinus: it consists of the orbital processes of the malar and maxillary bones, and of the small portion of the palate bone which rests on the latter; towards the inner and anterior border, near the lachrymal canal, may be observed a slight roughness, for the attachment of the obliquus inferior muscle; posteriorly, a groove, terminating in the infra-orbital canal, which runs nearly horizontally forwards. The inner side or wall of the orbit runs directly backwards, being parallel with the corresponding side of the other orbit, and is composed of the ascending process of the maxillary bone, the os unguis, the os planum of the ethmoid, and part of the body of the sphenoid

PLATE XXII.

The ligaments of the wrist and hand.

Fig. 1. The ligaments of the anterior aspect of the wrist and fingers.

No. 1. The lower part of the radius. 2. The lower part of the ulna. 3. The inferior part of the interosseous ligament. 4. The anterior ligament of the inferior radio-ulnar articulation. 5. The anterior ligament of the wrist-joint. 6. The external lateral ligament. 7. The internal lateral ligament. 8. The pointed extremity of the scaphoid bone. 9. The ridge of the trapezium. 10. The pisiform bone. 11. The hook-like process of the unciform bone. 12. The anterior prominence of the os magnum. 13, 13. Anterior ligaments of the carpal bones. 14, 14. Lateral ligaments of the carpus. 15, 15. Anterior ligaments of the carpo-metacarpal articulation. 16. The capsular ligament of the carpo-metacarpal articulation of the thumb. 17. A strong ligament passing between the pisiform bone and the hook-like process of the unciform bone. 18. The tendon of the extensor ossis metacarpi pollicis, divided close to its insertion. 19. One of the lateral ligaments of the metacarpo-phalangeal joint of the thumb. 20, 20. Sesamoid bones of this articulation. 21. One of the lateral ligaments of the phalangeal articulation of the thumb. 22. Anterior ligament of the metacarpo-phalangeal articulation of the index finger. 23, 23. Lateral ligaments of the metacarpo-phalangeal articulation of the index finger. 24, 24. Transverse ligaments. 25, 25. Anterior ligaments of the phalangeal articulations of the index finger. 26, 26. Lateral ligaments of the phalangeal articulations of the index finger. 27, 27. The theca of the flexor tendons laid open through its entire extent in the middle finger. 28. The theca of the flexor tendons unopened; farther onwards, the theca is laid open, and the tendons are exhibited. 29, 29. The tendon of the deep flexor, bifurcating into two slips, between which the tendon of the superficial flexor passes on to the last phalanx. 30. The tendon of the superficial flexor. 31. The tendon of the deep flexor muscle, dividing into two slips.

Fig. 2. The ligaments of the posterior aspect of the wrist and fingers.

No. 1. The lower part of the radius. 2. Its styloid process. 3. The lower part of the ulna. 4. Part of the interosseous ligament. 5. The posterior ligament of the inferior radio-ulnar articulation. 6. The posterior ligament of the wrist-joint. 7. The internal lateral ligament. 8. The external lateral ligament. 9, 9. The posterior ligaments of the carpus. 10, 10. The dorsal carpo-metacarpal ligaments. 11, 11. Transverse bands connecting the bases of the metacarpal bones of the fingers. 12. The capsular ligament of the carpo-metacarpal articulation of the thumb. 13. The tendon of the extensor ossis metacarpi pollicis, divided close to its insertion. 14. One lateral ligament of the metacarpo-phalangeal articulation of the thumb. 15. One of the sesamoid bones of the metacarpo-phalangeal articulation of the thumb. 16. One of the lateral ligaments of the phalangeal articulation of the thumb. 17. The tendon of the extensor secundi internodii pollicis muscle, divided close to its insertion. 18, 18. The lateral ligaments of the metacarpo-phalangeal articulation of the index and middle fingers. 19. The cavity of the articulation in the index finger. 20. The synovial membrane drawn aside in order to show the cavity of the articulation in the middle finger. 21, 21. The lateral ligaments of the phalangeal articulations of the index and middle fingers. 22, 22. The cavity of the articulation exposed in the middle finger by drawing aside the synovial membrane. 23, 23. The transverse ligament connecting the heads of the metacarpal bones. 24, 24. The tendon of the extensor communis digitorum muscle covering the dorsal surface of the ring and little fingers, and concealing the articulations.

Fig. 3. Vertical section of the carpus, showing the interosseous ligaments connecting the different bones, with the synovial cavity between them.

No. 1. The scaphoid bone. 2. The os semilunare. 3. The os cuneiforme. 4. The os trapezium. 5. The os trapezoides. 6. The os magnum. 7. The os unciforme. 8. The base of the metacarpal bone of the index finger. 9, 9. The bases of the metacarpal bones of the three other fingers. 10, 10. The synovial cavity between the first and second range of carpal bones. 11, 11. The synovial cavity between the second range and the metacarpal bones. 12, 12. The carpal portion of the synovial membrane of the wrist-joint. 13. The interosseous ligament connecting the scaphoid with the semilunar bone. 14. The interosseous ligament connecting the os semilunare with the os cuneiforme. 15. The ligament connecting the os magnum with the scaphoid bone and os trapezoides. 16. The ligament connecting the os magnum with the os unciforme. 17, 17. The interosseous ligaments connecting the bases of the metacarpal bones.

Fig. 4. The inferior articular surface of the bones of the fore-arm, showing the triangular fibro-cartilage.

No. 1. The articular surface of the radius. 2. The triangular fibro-cartilage. 3. The styloid process of the ulna.

Fig. 5. Vertical section of a finger, showing the lateral ligaments and the cavities of its articulations.

Nos. 1, 1. Lateral ligaments. 2, 2. Cavities of the articulations.

Plate 22.

Fig. 1.

Fig. 4.

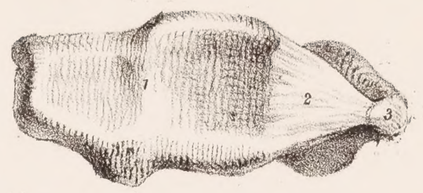

Fig. 3.

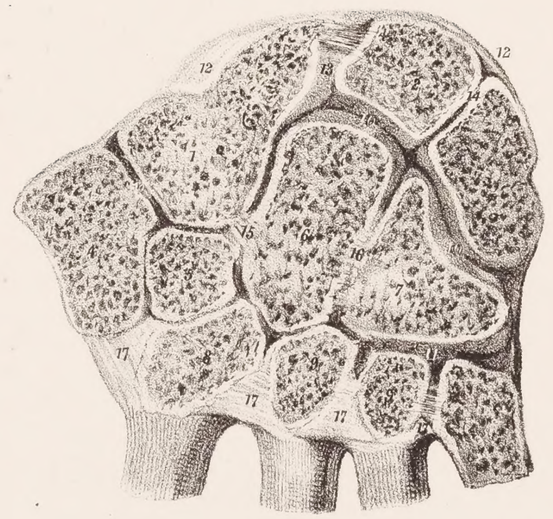

Fig. 5.

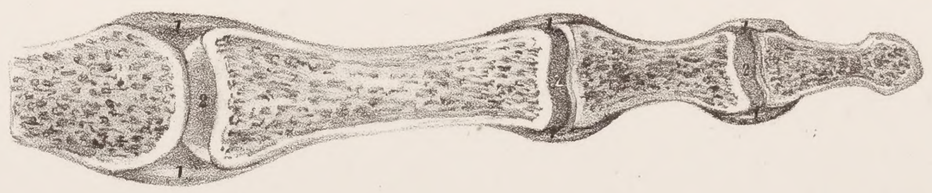

Fig. 2.

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Plate 23.

Fig. 1.

Fig. 4.

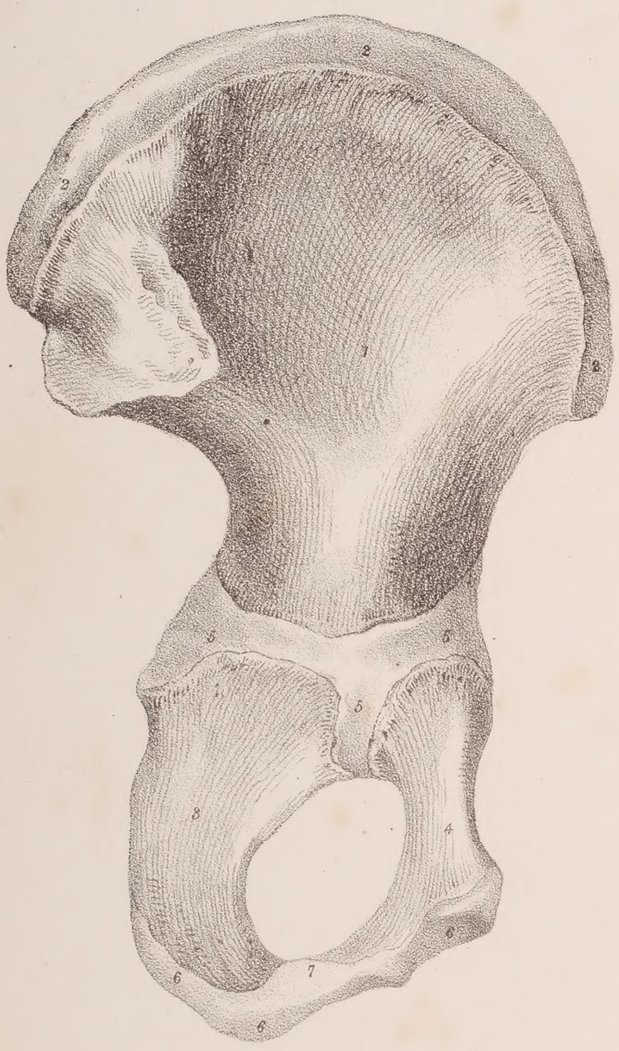

Fig. 3.

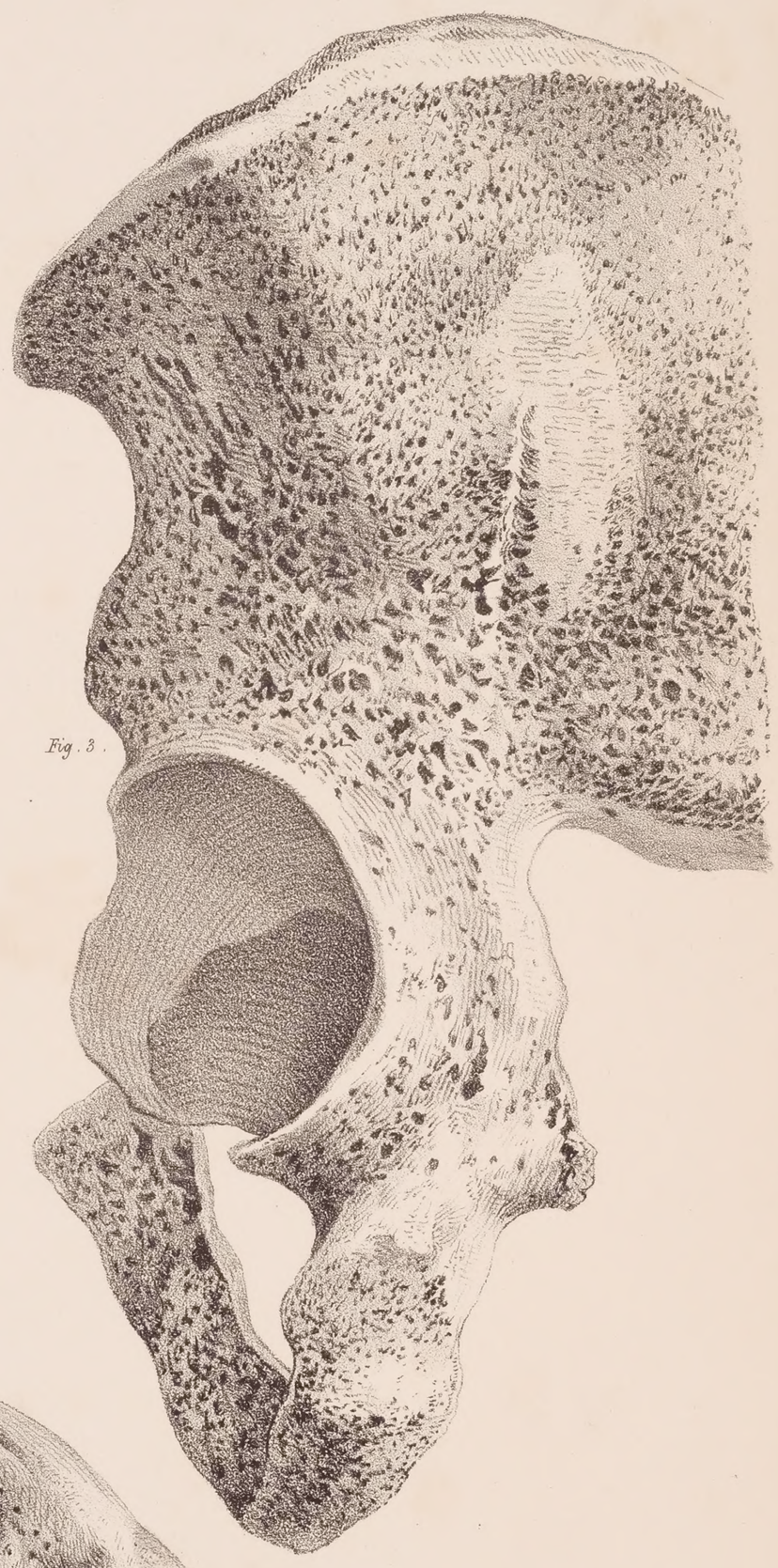

Fig. 5.

Fig. 2.

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bone. Near the anterior border is situated the *lachrymal canal*, which is formed, for the most part, between the ascending process and body of the maxillary bone, the remainder being made up by the groove in the os unguis, and a small process of the inferior spongy bone; this canal, a little expanded at its extremities, is directed downwards, backwards, and a little outwards. The *outer* side of the orbit, composed of the orbital plates of the malar and sphenoid bones, presents some minute foramina, which transmit small nerves from the orbit to the temporal fossa.

The *superior internal angle*, formed by the junction of the orbital process of the frontal bone with the os unguis and os planum, presents two foramina (*foramen orbitale internum, anterius, et posterius*), which give transmission, the anterior to the nasal twig of the ophthalmic nerve, the posterior to the ethmoidal artery. The *internal inferior angle* is rounded off so as to be scarcely recognised; it is formed by the union of the os unguis and os planum with the orbital plates of the superior maxillary and palate bones. In the *external superior angle*, formed by the malar, frontal, and sphenoid bones, is observed the sphenoidal fissure, of a triangular form, situated obliquely, its base being internal and inferior, the apex external and superior. In the *inferior external angle*, formed by the malar, the great ala of the sphenoid, the maxillary and palate bones, is situated the spheno-maxillary fissure, inclined at an angle with the former, and communicating with it, but of a different form, being broad at its extremities, and narrow at the centre.

PLATE XXIII.

Anatomy of the os innominatum.

Fig. 1. The os innominatum of the left side: after Cheselden.

No. 1. The ilium; its external or convex surface. 2, 2. The superior curved line of the ilium. 3, 3. The inferior curved line. 4, 4. That part of the surface of the bone from which the gluteus medius arises. 5, 5. The rough surface from which the gluteus maximus arises. 6, 6. The surface for the origin of the gluteus minimus. 7. The rough surface which gives origin to one head of the rectus muscle. 8, 8. The superior part of the lip of the acetabulum, which forms the inferior boundary of the ilium. 9, 9. The crest of the ilium. 10. Its anterior superior spinous process. 11. Its posterior superior spinous process. 12. The notch from the upper part of which the sartorius muscle arises. 13. The anterior inferior spinous process. 14. The posterior inferior spinous process. 15, 15. The great sacro-ischiatic notch. 16. The spine of the ischium. 17. The lesser sacro-ischiatic notch. 18. The body of the ischium. 19, 19. The posterior part of the lip of the acetabulum, which is formed by the ischium. 20. The tuberosity of the ischium. 21. The facet upon this tuberosity which gives origin to the semi-tendinosus muscle and the long head of the biceps. 22. The facet which gives origin to the semi-membranosus muscle. 23. The ramus of the ischium. 24. The body of the os pubis. 25. The crest of this bone. 26. The spine, or tuberosity of the os pubis. 27. The angle of the bone. 28. The edge of the articular surface of the os pubis. 29. The rough surface immediately beneath the angle from which the tendon of the adductor longus muscle arises. 30. The ilio-pectineal line. 31. The ilio-pectineal eminence. 32. The anterior portion of the lip of the acetabulum formed by the os pubis. 33. The notch in the acetabulum. 34, 34. The articular surface of the acetabulum. 35. The depression at the bottom of the acetabulum which lodges the cushion of fat of the ilio-femoral articulation. 36. The obturator foramen. 37. The groove upon the under surface of the os pubis which gives passage to the obturator vessels.

Fig. 2. The os innominatum of the right side, seen upon its internal aspect: after Cheselden.

No. 1. The concavity of the ilium, which lodges the iliacus muscle. 2, 2. The crista ilii. 3. The anterior superior spinous process. 4. The posterior superior spinous process. 5. The anterior inferior spinous process. 6. The notch between the anterior spinous processes. 7. The posterior inferior spinous process. 8. The ilio-pectineal eminence. 9. The upper margin of the acetabulum. 10, 10. The ilio-pectineal line. 11, 11. The auricular portion of the ilium, which articulates with the sacrum. 12, 12. The rough portion of the bone, which is connected with the sacrum by means of interosseous ligaments. 13. The ischium. 14, 14. The great sacro-ischiatic notch. 15. The spine of the ischium. 16. The lesser sacro-ischiatic notch. 17. The tuberosity of the ischium. 18. The border of the tuberosity of the ischium to which the great sacro-ischiatic ligament is attached. 19. The ramus of the ischium. 20. The body of the os pubis. 21. Its crest. 22. The spine or tuberosity. 23. The angle. 24, 24. The articular surface of the bone. 25. The ramus of the os pubis. 26. The obturator foramen.

Fig. 3. A portion of the os innominatum, from which the external table of the bone has been removed, in order to show its cellular or cancellous structure: after Cheselden.

Fig. 4. The os innominatum of the young subject, showing the mode of developement of the bone by three portions, corresponding with the ilium, ischium, and os pubis, and their cartilaginous union at the acetabulum: after Cheselden.

No. 1. The ilium. 2, 2. The crest of the bone, which is as yet cartilaginous. 3. The ischium. 4. The os pubis. 5, 5. The cartilage connecting these three pieces at the acetabulum. 6, 6. The cartilaginous rim of the tuberosity of the ischium, and rami of the ischium and pubis. 7. The cartilaginous union between the two rami.

Fig. 5. The os innominatum of a fœtus, showing the bone at a still earlier stage of developement: after Cheselden.

The *anterior extremity*, or *base*, of the orbit, is directed outwards and forwards; and, as if to provide for a free range of lateral vision, the external wall retreats in some degree, and does not extend as far forward as the internal. The inner termination of the cavity, representing the summit of a pyramid, to which it has been likened, corresponds with the optic foramen. In each orbit, parts of seven bones are observed, viz. the frontal, ethmoid, sphenoid, os unguis, malar, maxillary, and palate bones; but as three of these, viz. the ethmoid, sphenoid, and frontal, are common to both, there are only eleven bones for the two orbits.

The Nasal Fossæ.—These fossæ are two cavities, placed one at each side of the median line, separated by a flat vertical septum. They communicate, by foramina, with the various sinuses lodged in the frontal, the ethmoid, and superior maxillary bones, and open anteriorly, on the surface, by the nares, and posteriorly into the pharynx. The roof, the floor, the inner and the outer walls of these cavities, require a separate consideration.

The *roof* is flat at its middle part, and sloped before and behind; it is formed in front by the inner surface of the nasal bones, behind by the body of the sphenoid, and in the middle by the horizontal or cribriform lamella of the ethmoid bone. The *floor*, smooth, concave from side to side, and formed by the palate plates of the maxillary and palate bones, extends backwards, and a little downwards, from the nares to the pharynx. Towards the anterior opening may be observed the superior orifice of the anterior palatine canal. The *internal wall*, or septum narium, which extends from the roof to the floor of the cavity, is flat, nearly vertical (the deviation, if any, being usually to the left side), and composed of the perpendicular plate of the ethmoid bone, the vomer, and the nasal cartilage. The *external wall* is formed by the ethmoid, superior maxillary, os unguis, inferior spongy, and palate bones. The posterior and inferior parts of this surface are marked by a number of inequalities, whilst the superior and anterior are comparatively even. In the latter situation may be observed, first, the smooth surface just mentioned; and, secondly, passing downwards and backwards, three, and frequently four, arched and convoluted bones (spongy bones), beneath which are grooves (*meatus*) leading from before backwards. The superior spongy bone is much shorter than the others; beneath it is the *superior meatus*, into which will be found opening, anteriorly, a foramen from the posterior ethmoidal cells, and, posteriorly, the spheno-palatine foramen. The middle spongy bone overhangs the *middle meatus*, which communicates with the anterior ethmoidal cells; one of these curves forwards and upwards, and is continuous with the frontal sinus; more posteriorly is situated the opening of the maxillary sinus. The *inferior meatus* situated below the inferior spongy bone, between it and the floor of the nasal cavity, is necessarily longer than the others; it presents anteriorly the orifice of the nasal canal.

The Frontal, Sphenoidal, and Maxillary Sinuses.—The *frontal sinuses* correspond with the superciliary eminences of the frontal bone. Of considerable size in the adult, but varying in different individuals, they are not at all developed in the fœtus. They are divided into two, sometimes three compartments.

The *sphenoidal sinuses*, two in number, are placed within the body of the sphenoid bone; these also cannot be said to exist in infancy. They are separated by a partition. Above, behind, and on each side, they are bounded by the body of the sphenoid bone, and in front by two small spongy bones (cornua sphenoidalia).

The *maxillary sinus* (antrum Highmori) is a large excavation in the body of the superior maxillary bone. It appears at an earlier period than any of the other sinuses, the developement commencing about the fourth month of fœtal life. Its form is irregularly pyramidal, the base being towards the nasal cavity, the apex corresponding with the malar tuberosity. Superiorly, it is enclosed by the orbital plate of the maxillary bone; and inferiorly by its palate plate: internally, it opens into the middle meatus of the nasal cavity by a foramen, which, though it appears very large in the dry bone when separated from its connexions, is in the natural state small, being little more than sufficient for the admission of a probe; this diminution of size is caused by the lower edge of the ethmoid, the inferior spongy and the palate bones, and also by a fold of the mucous membrane.

Analogy between Cranial Bones and Vertebræ.—Anatomists have at all times perceived and recognised the analogy between the movable and motionless pieces of the spine—between those of the lumbar and dorsal regions, and those of the sacrum and coccyx: in the one, as well as in the other, similar organic elements are observed to exist, variously modified, in order to suit special purposes; but it is only of late years that any adequate attention has been directed to the points of similitude which exist between vertebræ, properly so called, and the cranial bones. Many persons who adopt, without hesitation, the terms false or pelvic vertebræ, as applied to the sacrum and coccyx, feel

a repugnance to use the word false or cranial, as applied to the pieces of the skull; and deny, perhaps without examination, the analogy upon which it is founded, as being unnatural, or far-fetched. We have numerous instances of the harmony that subsists between containing and contained parts throughout the economy; in no case is it more striking than in the relation that obtains between the fundamental part of the osseous structure and the central mass of the nervous system. The spinal canal is accurately adapted in its different parts to the nervous cord which it encloses. In the pelvic region, the canal, at least in the human subject, becomes narrow, as it merely encloses nerves, whilst the body and processes take on a particular developement to meet a special purpose, that of forming a basis of support for the rest of the column. This seems to result from the working of what may be termed a principle of compensation in the growth, as well as in the action of parts; for when one part of a given whole is developed to excess or to a maximum, others will remain at a minimum or atrophied: thus the spinal canal and the arches are at their minimum in the sacrum and coccyx, for the contained parts are there at a low point of developement; but at the opposite end of the column the reverse obtains; the contained parts, viz. the central parts of the nervous system, are evolved in the human subject to the greatest extent, and so must the containing parts also be. The portion of the osseous system which corresponds with the bodies of the vertebræ can, therefore, hardly be recognised; whilst that which is analogous to the arches is expanded so much as to retain but a slight similitude to them.

If we take the occipital bone, and examine it attentively, we shall readily perceive in it all the elements of a vertebra. The foramen magnum is the counterpart of the ring of a vertebra, and has a similar relation to the spinal cord; the basilar process represents the body; the condyles are true articulating processes; the rough surfaces external to them, and which give attachment to the recti laterales, correspond to the transverse processes; the vertical ridge extended backwards along the median line, from the foramen to the occipital protuberance, is, in the human subject, merely a rudiment of a spinal process; but in the dog, bear, and badger, it forms a sharp prominence well deserving the name of spine, and the likeness is still more striking in osseous fishes: finally, the broad plates on each side of the spine represent the arches. In this view of the matter, the occipital bone forms the first false vertebra of the cranial region.

In the second cranial piece or vertebra, it must be admitted that the analogies are not so striking; but when we recollect that the cavity of the skull, if examined in the different orders of animals, enlarges in proportion as the brain acquires an increase of developement, and that this enlargement attains its maximum in the human subject, we shall at once find sufficient reason to expect that the parts corresponding with the vertebral arches should, in this region, be greatly evolved, while the rest are in a manner atrophied. The parietal bones, with the squamous part of the temporal and the great wings of the sphenoid, taken together, represent the arches, whilst the posterior part of the sphenoid bone (such as it exists in the human fœtus before its ossification is complete, and such as it continues permanently in several lower animals,) is the counterpart of the body; the mastoid processes of the temporal bones with the glenoid fossæ serve as transverse and articulating processes. These, together, form the middle cranial piece, which may be termed the spheno-temporo-parietal cranial false vertebra.

The frontal bone, the ethmoid, and the anterior division of the sphenoid (which is that part of the body that sustains the smaller wings), form the third vertebra; the part of the sphenoid just named, together with the crista galli and the perpendicular plate of the ethmoid bone, form the body, which is here reduced to a rudimentary state, just as the coccygeal bones are at the opposite end of the column, of which it may be considered a repetition. The lateral and expanded parts of the frontal bone are the arches, and the external orbital processes may be likened to transverse processes.

We have here used the term false vertebra as applied to the cranial pieces; perhaps it would be better to use the word zone, as sanctioned by the authority of Cuvier. The passage in which he recognises the principle of developement here indicated, as well as the application of it, (which appears to have been first inculcated by Dumeril, and traced in all its details by Geoffroy Saint-Hilaire,) is as follows:—" Le crâne se subdivise comme en trois ceintures, formées—l'antérieure par les deux frontaux et l'éthmoide, l'intermédiaire par les pariétaux et le sphénoide, la postérieure par l'occipital." *

Man adapted to the erect posture.—Every part of the conformation of the human subject

* Règne Animal, tom. i. p. 63.

indicates its adaptation to the erect position. The feet are broader than those of any other animal proportionally to its size; the tarsal and metatarsal bones admit of very little motion; and the great toe is on the same plane with the others, and cannot be brought into opposition with them. The foot is thus fitted to sustain the weight of the body, but not to grasp or seize objects presented to it. The hands, on the contrary, though so well adapted for these purposes, are ill calculated for affording support; so that man is truly "bimanous" and "biped." * The tibia rests perpendicularly on the astragalus, and the os calcis projects backwards for the purpose of increasing the base, and also of lengthening the lever to which the strong muscles of the calf of the leg are attached. The whole extent of the tarsus, metatarsus, and phalanges, in man, rests on the ground, which does not obtain even in apes, the end of whose os calcis is

PLATE XXIV.

Bones of the lower extremity.

Fig. 1. Femur of the right thigh, seen upon its anterior aspect: after Cheselden.

No. 1. The shaft of the bone. 2. Its head. 3. The indentation on the head of the femur for the insertion of the ligamentum teres. 4. The neck of the bone, somewhat fore-shortened. 5. The trochanter major. 6. The rough surface for the attachment of the tendon of the gluteus minimus muscle. 7, 7. The anterior inter-trochanteric line. 8. The trochanter minor. 9, 9. Foramina upon the neck of the bone for the passage of nutrient vessels. 10. The internal and longer condyle of the femur. 11. The tubercle which gives attachment to the tendon of the adductor magnus muscle. 12. The tubercle for the attachment of the internal lateral ligament of the knee-joint. 13. The external condyle. 14. The tubercle for the attachment of the external lateral ligament of the knee-joint. 15. The groove for the tendon of origin of the popliteus muscle. 16. Foramina for the passage of nutritious vessels into the cancellous structure of the lower extremity of the femur.

Fig. 2. The left femur, seen upon its posterior surface: after Cheselden.

No. 1. The shaft of the bone. 2. Its head. 3. The depression for the insertion of the ligamentum teres. 4. The neck of the femur. 5. The trochanter major. 6. A part of the surface for the attachment of the tendon of the gluteus medius. 7. The linea quadrati, for the attachment of the quadratus femoris muscle. 8. The posterior inter-trochanteric line. 9. The trochanter minor. 10, 10. The trochanteric or digital fossa. 11, 11. The line leading from the base of the greater trochanter to the linea aspera, for the attachment of the gluteus maximus. 12. The ridge for the attachment of the upper part of the adductor magnus muscle. 13, 13. The line passing down from the anterior inter-trochanteric line to the linea aspera, for the attachment of the pectineus muscle. 14, 14. The linea aspera. 15. The nutritious foramen of the femur. 16. The outer lip of the linea aspera, continued downwards to the external condyle. 17, 17. The continuation of the internal lip of the linea aspera down to the internal condyle. 18. A slight groove on the bone, at which the internal lip of the linea aspera is deficient. This groove supports the femoral artery at the point of its passage through the tendon of the adductor magnus. 19. The surface of the femur which forms part of the floor of the popliteal space. 20. The external condyle. 21. The tubercle for the attachment of the external lateral ligament of the knee-joint. 22. The internal condyle. 23. The tubercle for the attachment of the internal lateral ligament. 24. The tubercle for the insertion of the tendon of the adductor magnus muscle. 25. Foramina for the transmission of nutritious vessels to the cancellous structure of the inferior extremity of the bone. 26. The inter-condyloid fossa.

Fig. 3. Vertical section of the shaft of the femur of a young subject: after Cheselden.

No. 1. The head of the bone. 2. The osseous centre by which the cartilage of the head of the bone is being converted into bone. 3. The trochanter major, consisting of cartilage without any ossific centre. 4, 4. The line of separation between the epiphysis and diaphysis of the bone. 5, 5. The cancellous structure of the upper extremity of the diaphysis. 6, 6. The dense structure of the shaft of the diaphysis of the bone. 7, 7. The medullary canal. 8, 8. The cancellous structure of the lower extremity of the diaphysis. 9. The epiphysis of the lower extremity of the bone. 10, 10. Its cartilaginous portion. 11, 11. Its ossifying centre.

Fig. 4. The bones of the left lower extremity of a fœtus; showing their epiphyses and diaphyses.

No. 1. The superior epiphysis of the femur, as yet in the state of cartilage. 2. The diaphysis. 3. The inferior epiphysis. 4. The patella, in the state of cartilage. 5. The superior epiphysis of the tibia. 6. The diaphysis of that bone. 7. The inferior epiphysis. 8. The superior epiphysis of the fibula. 9. The diaphysis of the fibula. 10. Its inferior epiphysis.

Fig. 5. A front view of the patella of the left leg: after Cheselden.

No. 1. The upper border of the bone. 2. Its inferior part or apex.

Fig. 6. The patella, seen upon its articular surface: after Cheselden.

No. 1. The upper border. 2. The apex. 3. The rough surface, to which the ligamentum patellæ is attached. 4. The surface for articulation with the external condyle of the femur. 5. The surface for articulation with the internal condyle.

Fig. 7. Section of the patella, showing its cancellous structure.

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* Règne Animal, tom. i. p. 82.

Fig. 1.

Fig. 2.

Fig. 3.

Fig. 4.

Fig. 5.

Fig. 7.

Fig. 6.

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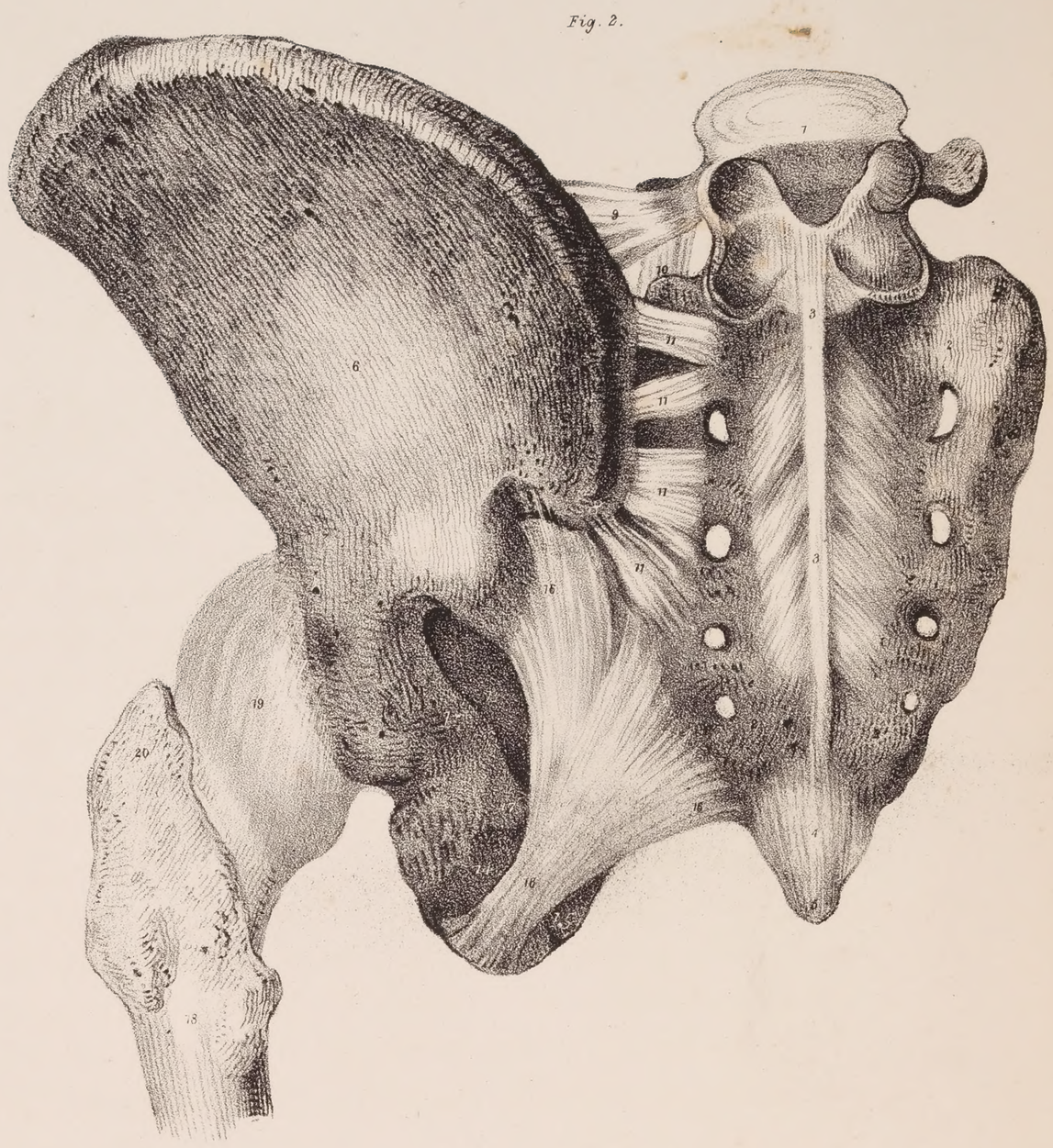
Fig. 1.

Fig. 2.



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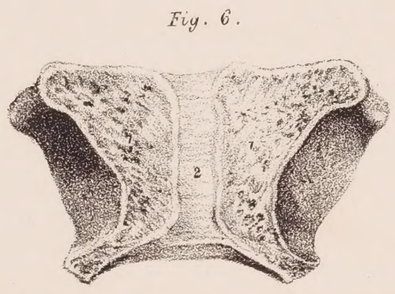

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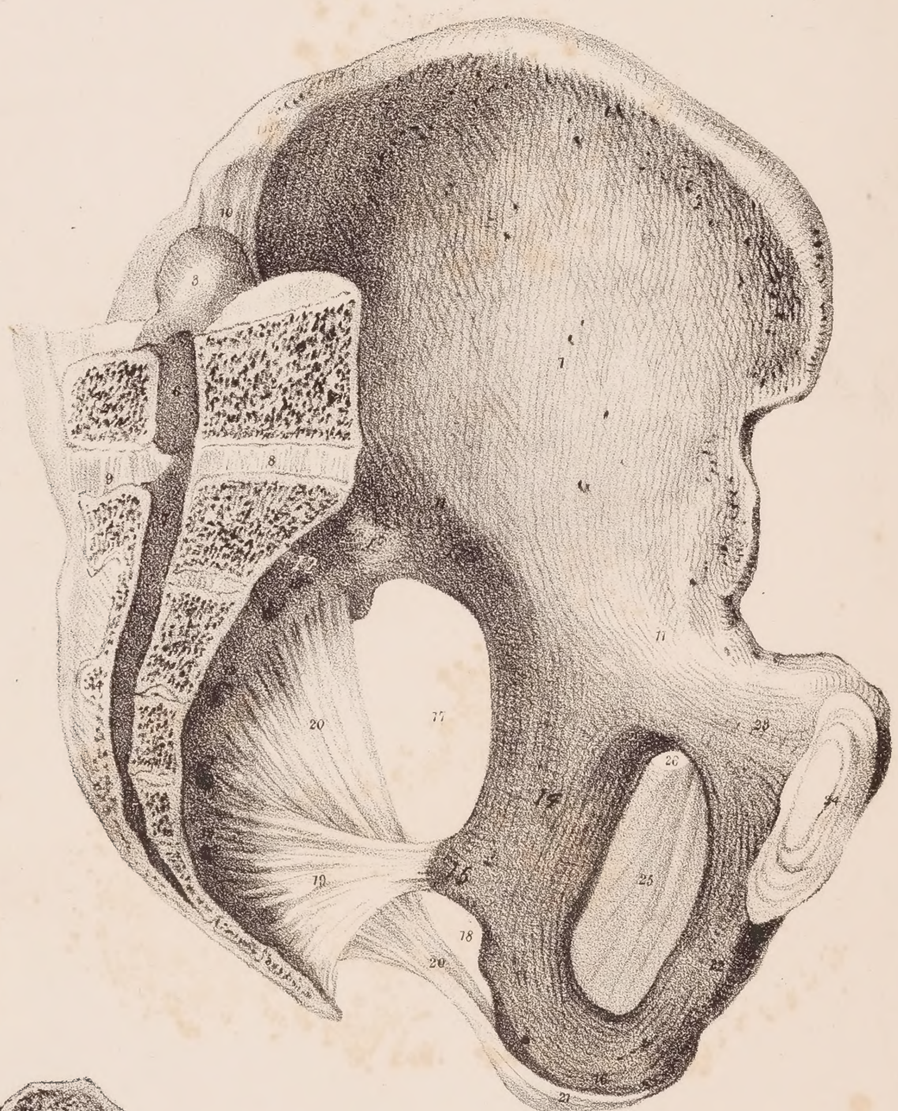

Fig. 5.

Fig. 7.

Fig. 8.

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somewhat raised, so as to form an acute angle with the bones of the leg. In dogs and digitated quadrupeds, the carpus and tarsus are considerably elevated from the ground, so that the body rests on the toes; and in the horse, and other solid-hoofed animals, the third phalanges only rest on the ground, the os calcis being raised nearly to the perpendicular direction.

The femur, placed securely beneath the pelvis, affords a firm support during progression. The great breadth of the pelvis serves to enlarge the base on which the trunk rests; and this is farther increased by the length of the cervix femoris. This peculiarity in the neck of the femur renders it necessary that the body of the bone should incline inwards, in order that its axis should approach the central line, and so support the centre of gravity. If its articular head be viewed in profile, it will be observed that the cartilaginous coating is distributed for the most part on its upper and inner aspect, showing its adaptation as a pillar of support in the erect position.

The bones of the pelvis in the human subject are distinguished from those of other animals by some marked peculiarities. The sacrum is remarkably broad and expanded, so as to form a firm support for the spinal column which rests upon it; its lower part is curved and articulated with the coccyx, so that both incline forwards and enclose the pelvic cavity, constituting a support for the viscera when pressed down by muscular action. If a different arrangement of these bones obtained—if they were continued downwards in a straight line, they would project beyond the ischia and render the sitting posture irksome or impossible.

The spinal column, which is supported on the pelvis, is peculiarly adapted to the erect attitude. Its pyramidal form and enlarged base fit it to sustain the superincumbent weight; and by means of the different curvatures which it presents, a considerable range of motion is allowed to the trunk, the centre of gravity being still supported within the base. The form of the thorax is also peculiar. Shallow and compressed from before backwards, it is broad and expanded from side to side; by which means the preponderance of the trunk forwards is considerably lessened. The sternum, though broad, is very short, so that a considerable space intervenes between it and the pubes, which is occupied solely by muscular parts. But in quadrupeds, the thorax is compressed and flattened laterally, becoming gradually narrower towards the sternum, which is prominent and keel-shaped, so that the breadth from this latter bone to the spine is much greater than that from side to side. This conformation, together with the absence of clavicles in true quadrupeds, enables the anterior extremities to approach closely together, and fall perpendicularly downwards beneath the trunk, so as to give it a steady support. The sternum is elongated in these animals, and the ribs pass from the spine to that bone so directly, without making any angle, that they approach near to the crista of the ilia, and thereby increase the extent of firm support necessary to sustain the weight of the viscera. Even with these advantages, the muscles of the abdomen would be inadequate to the support of its contents, were they not

PLATE XXV.

The ligaments of the pelvis and hip-joint.

Fig. 1. The left side of the pelvis, showing its ligaments and the capsular ligament of the hip-joint, seen from the front.

No. 1. The last lumbar vertebra. 2, 2. The transverse processes of this vertebra. 3, 3. The front surface of the sacrum. 4. The anterior common ligament of the vertebral column. 5, 5. The inter-vertebral substance between the body of the last lumbar vertebra and the base of the sacrum. 6. The anterior sacro-coccygean ligament. 7. The internal and concave surface of the ilium, or iliac fossa. 8, 8. The ilio-pectineal line. 9. The internal surface of the ischium. 10. The ilio-lumbar ligament. 11. The sacro-vertebral ligament. 12, 12. The anterior sacro-iliac ligaments. 13, 13. The anterior surface of the ossa pubis. 14. The anterior pubic ligament. 15. The superior pubic ligament. 16. The inferior or sub-pubic ligament. 17. The ramus of the pubis and ischium. 18. The tuberosity of the ischium. 19. The obturator ligament or membrane. 20. The aperture left between the upper border of this ligament and the os pubis for the passage of the obturator vessels and nerve. 21, 21. The capsular ligament of the hip-joint. 22. A ligamentous band which strengthens this capsule,—the ilio-femoral ligament. 23. The border of the transverse ligament of the acetabulum. 24. The notch in the acetabulum for the transmission of vessels and nerves. 25. The head of the femur. 26. The great trochanter. 27. The lesser trochanter.

Fig. 2. The ligaments of the pelvis and the capsular ligament of the hip-joint, seen from behind.

No. 1. The last lumbar vertebra. 2, 2. The posterior surface of the sacrum. 3, 3. The continuation of the supra-spinous ligament of the vertebræ. 4. The posterior sacro-coccygean ligament. 5. The tip of the coccyx. 6. The ilium, seen upon its external and convex surface. 7, 7. The crest of the ilium. 8.

assisted by a layer of elastic substance, which is placed over their entire extent, and which of itself marks their destination for the prone position.

Though the upper and lower extremities present several points of similitude, they yet may be contrasted so as to show that they are adapted to totally different purposes. It is quite obvious that the scapula and os innominatum, the humerus and the femur, the bones of the fore-arm and those of the leg, the hand and the foot, are respectively constructed on the same plan; but the differences which they present indicate a difference of function.

The scapulæ, placed on the supero-posterior part of the trunk, are borne off by the clavicles; their glenoid cavities are directed forwards and outwards, so that the arms, which are, as it were, appended to them, are fitted to enjoy a considerable degree of motion in the anterior and lateral directions. But in true quadrupeds the glenoid cavities look downwards, and are approximated closely together, so that the thoracic limbs, which are articulated with them, descend beneath the fore part of the trunk; and, as they are thus calculated to support its weight, they possess little lateral motion. The glenoid cavity in man is quite shallow, so that the globular

The posterior and superior spinous process of the ilium. 9. The ilio-lumbar ligament. 10. The sacro-vertebral ligament. 11, 11. Posterior sacro-iliac ligaments. 12. The posterior part of the body of the ischium. 13. The great sacro-ischiatic foramen. 14. The lesser sacro-ischiatic foramen. 15. The tuberosity of the ischium. 16, 16. The great sacro-ischiatic ligament. 17. The spine of the ischium, to which the lesser sacro-ischiatic ligament is attached. 18. The upper extremity of the femur. 19. The capsular ligament of the hip-joint. 20. The greater trochanter of the femur. 21. The lesser trochanter.

Fig. 3. A side view of the pelvis, seen from its external aspect, and showing its ligaments.

No. 1. The external surface of the ilium. 2, 2. The posterior surface of the sacrum. 3. The coccyx. 4. The ischium. 5. Its spine. 6. Its tuberosity. 7, 7. The great sacro-ischiatic ligament. 8, 8. The lesser sacro-ischiatic ligament. 9. The great sacro-ischiatic foramen. 10. The lesser sacro-ischiatic foramen. 11. The acetabulum. 12, 12. The cotyloid ligament of the articulation of the hip-joint. 13. The transverse ligament. 14. The os pubis. 15. The ramus of the pubis and ischium. 16. The obturator membrane.

Fig. 4. A side view of the pelvis, seen from within. This view has been made by means of a section carried through the middle line of the cavity, and dividing the sacrum and coccyx behind, and the symphysis pubis in front.

No. 1. The inner surface of the ilium, or iliac fossa. 2, 2. A section of the last lumbar vertebra. 3. Its transverse process. 4, 4. Section of the sacrum. 5. Section of the coccyx. 6. The lower part of the spinal canal. 7, 7. The sacral canal. 8. The intervertebral ligament connecting the body of the last lumbar vertebra with the superior articular surface of the sacrum. 9. The interspinous ligament between the spinous process of the last lumbar vertebra and the superior spinous process of the sacrum. 10. The ilio-lumbar ligament. 11, 11. The ilio-pectineal line. 12, 12. The anterior surface of the sacrum. 13. The anterior sacro-iliac ligaments. 14. The internal surface of the ischium. 15. The spine of the ischium. 16. The tuberosity of the ischium. 17. The great sacro-ischiatic foramen. 18. The lesser sacro-ischiatic foramen. 19. The lesser sacro-ischiatic ligament. 20, 20. The great sacro-ischiatic ligament. 21. That portion of the great sacro-ischiatic ligament which is attached to the inner border of the tuberosity of the ischium. 22. The ramus of the pubis and ischium. 23. The internal surface of the os pubis. 24. The articular surface of the pubis, which unites with its fellow of the opposite side at the symphysis. 25. The obturator membrane. 26. The aperture between the upper border of the obturator membrane and the bone which gives passage to the obturator vessels and nerve.

Fig. 5. The ossa pubis and their articulation, seen from the inner aspect of the pelvis.

Nos. 1, 1. The inner surface of the ossa pubis. 2, 2. The ramus of the pubis and ischium at each side. 3, 3. The tuberosity of the ischium at each side. 4, 4. A part of the acetabulum at either side. 5, 5. The transverse ligament of the acetabulum. 6, 6. The notch of the acetabulum, converted into a foramen by the transverse ligament. 7, 7. The obturator membrane. 8, 8. The opening for the passage of the obturator vessels and nerve. 9. The symphysis pubis; its internal ligament. 10. The superior pubic ligament. 11. The sub-pubic ligament.

Fig. 6. A section carried through the anterior part of the bodies of the ossa pubis, in order to show the fibrous tissue which connects the articular surfaces of these bones.

Nos. 1, 1. The cut surface of the pubic bones. 2. The fibrous tissue connecting the articular surfaces of the ossa pubis.

Fig. 7. The capsular ligament of the hip-joint, and the bones entering into the formation of this articulation.

No. 1. The anterior inferior spinous process of the ilium. 2. A part of the os pubis. 3. A part of the ischium. 4. The great trochanter of the femur. 5, 5. The capsular ligament of the hip-joint. 6, 6. The ilio-femoral ligament. 7. The notch in the acetabulum for the passage of the vessels and nerves of the hip-joint. 8. The upper part of the shaft of the femur. 9. The lesser trochanter.

Fig. 8. The hip-joint laid open, and the capsular ligament removed: from Cheselden.

No. 1. A part of the ilium. 2. The anterior and inferior spinous process of the ilium. 3, 3. The lip of the acetabulum. 4. The cup of the acetabulum. 5. The fossa at the bottom of the acetabulum. 6, 6. The cotyloid ligament. 7. The transverse ligament. 8, 8. The ligamentum teres. 9. The head of the femur covered with cartilage. 10. The neck of the femur. 11. The trochanter major. 12. The upper part of the shaft of the femur. 13. The ramus of the pubis and ischium. 14. The body of the os pubis. 15. The obturator foramen.

head of the humerus is merely applied to its surface; but the acetabulum is a deep cup-like cavity, indicating a quite different destination in the two joints. The breadth of the articular surfaces of the knee-joint, and the peculiar conformation of the ankle-joint, as contrasted with the elbow and wrist, are abundantly sufficient to show that fixity and strength have been designed in the one, mobility in the other. This difference is, if possible, more strongly marked in the conformation of the hand and foot: the latter, as has been already observed, being intended to support the body, is placed at right angles beneath the leg; the former is continuous with the line of direction of the fore-arm, otherwise it could not be guided with sufficient precision to the different objects which it is intended to seize. The tarsal bones are large, firm and strong; those of the metatarsus are also thick and large, and placed all in a line. That which supports the great toe being the stoutest of all, and almost immovable, ranges with the others. But the metacarpal bones are quite differently disposed; that which supports the thumb admits of considerable motion in every direction, so as to perform a complete circumduction, and is placed so much out of line with the others that it can be opposed to them, as in grasping different objects. The hand and foot may be considered as divisible each into two parts, differing in their degrees of mobility, viz. the digital phalanges, and the row of bones which sustains them. The movable phalanges of the hand are as long as the carpal and metacarpal bones taken together; but in the foot, they are not a third of the length of the tarsal and metatarsal bones.

No part of the osseous system of man affords more striking evidence of his adaptation for the erect posture than the cranium. Resting on the summit of the vertebral column, the line of its base forms a right angle with that of the column itself, which thus affords it a firm support. The condyles, or points of articulation, are situated very near the centre of its base, being, however, a little nearer to the occipital protuberance than to the anterior surface of the jaws; by this arrangement, very little active power is required to maintain it *in equilibrio*.* In other animals the condyles are placed much further back; so that, instead of resting on the column, the skull is, as it were, appended to its extremity, and is sustained by an elastic substance, (ligamentum nuchæ,) which is attached by one extremity to the spinous processes of the vertebræ, and by the other to the occipital protuberance. The head, as has been already observed, is composed of two parts, the cranium and face; the one being intended to contain the brain—the material instrument of the mind; the other to enclose the organs of sight, smell, and taste. The more the organs of smell and taste are developed, the greater is the size of the face, and the greater its relative proportion to the cranium. On the contrary, the larger the brain, the greater must be the capacity of the skull, and the greater its proportion to the face. On this principle, a large cranium and a small face indicate a large brain with a restricted developement of the sense of smell and taste; but a small cranium and a large face mark an opposite conformation. The character and nature of animals is determined by the degree of energy with which their different functions are performed; they are guided and impelled by some leading propensity or disposition; and as the cranium and face bear to the brain and organs of sense the relation of containing and contained parts, the study of their relative proportions is one of great interest to the naturalist, inasmuch as they serve as indices of the faculties, instincts, and capabilities of different individuals as well as of classes.

Several methods have been suggested for determining the proportion of the cranium to the face; the simplest is that of Camper. If a line be drawn upwards from the side of the chin over the most prominent part of the forehead, it will form an angle with a horizontal line drawn backwards over the external auditory foramen from the margin of the anterior nares; the size of the angle will indicate the degree of developement of the cranium and brain, as compared with that of the face and organs of sense. In the crocodile these lines are so nearly coincident, that there is scarcely any appreciable angle.

In the Horse it measures †	23°
Ram	30
Dog	35
Ouran-outang	56 to 60
European adult	85

Thus we find man at the top of the scale of animated beings, distinguished from all the rest as well by his external conformation as by his internal organization. When the mind has passed

* Lawrence on the Characters of the Human Head, passim. † Cuvier, Leçons d'Anatomie Comparée, tom. ii. p. 8.

in review the many links of the chain which connects the lowest with the highest—the mere animated dot, with man, the lord of the creation, it cannot fail to be struck with astonishment at the immense chasm which separates them. Yet, when each link of the chain is compared with that which precedes and follows it, the transition from the one to the other is found to be so gradual as to be almost imperceptible. So easy are the steps of ascent from the organisation of the higher orders of the quadrumana, up to the human species, that even Linnæus felt it difficult to assign the specific characters by which man is distinguishable from all others; but any doubt that may have existed on this subject has been long since removed. The physical and moral attributes of man are universally recognised as sufficient to elevate him much further from the higher mammalia than these are from the classes beneath them; and in the opinion of Cuvier,* he should be considered not merely as a distinct species, but even as forming a separate order by himself. Whether, then, with the zoologist, we consider the physical conformation of man

PLATE XXVI.

The bones and ligaments of the leg.

Fig. 1. The tibia and fibula of the left leg in their articulated position : after Cheselden.

No. 1. The head of the tibia. 2. Its spinous process. 3. The surface of the head of the bone, for articulation with the inner condyle of the femur. 4. The external tuberosity of the tibia. 5. The internal tuberosity. 6. The tubercle of the tibia for the attachment of the ligamentum patellæ. 7. A smooth surface immediately above the tubercle, corresponding with the situation of a bursa mucosa. 8, 8. The subcutaneous surface of the shaft of the tibia. 9, 9. The concave external surface, which gives attachment to the tibialis anticus muscle. 10. The ridge for the attachment of the interosseous membrane. 11. The surface behind this ridge, which gives attachment to one head of the tibialis posticus muscle. 12. The inferior extremity of the tibia. 13. The internal malleolus of the tibia. 14. The upper extremity of the fibula. 15. That portion of the head of the fibula which gives attachment to the external lateral ligament of the knee-joint. 16, 16. The shaft of the fibula; its external surface. 17, 17. The internal surface of the fibula. 18. The lower extremity of this bone, forming the external malleolus of the ankle. 19, 19. The subcutaneous surface of the external malleolus.

Fig. 2. The tibia of the right leg, seen upon its posterior surface: after Cheselden.

No. 1. The head of the bone. 2. The spinous process of the tibia. 3. The surface of articulation for the inner condyle of the femur. 4. The surface of articulation for the external condyle of the femur. 5. The inner tuberosity of the tibia. 6. The fossa upon this tuberosity for the insertion of the tendon of the semi-membranous muscle. 7. The outer tuberosity of the tibia. 8. The smooth surface on this tuberosity for articulation with the head of the fibula. 9. The oblique line of the tibia. 10. The surface above the oblique line for the attachment of the popliteus muscle. 11, 11. The posterior surface of the shaft of the tibia. 12. The nutritious foramen of the tibia. 13, 13. The interosseous line upon the external aspect of the tibia. 14. The surface of the tibia which gives origin to the internal head of the tibialis posticus muscle. 15, 15. The external surface of the shaft of the tibia, corresponding with the anterior muscles of the leg. 16. The lower extremity of the tibia. 17. The surface at the lower extremity of the tibia for articulation with the fibula. 18. A slight groove for the support of the tendon of the flexor longus pollicis. 19. A deeper groove for the tendons of the tibialis posticus and flexor longus digitorum. 20. The internal malleolus of the tibia. 21. The surface which articulates with the astragalus.

Fig. 3. The fibula of the right leg, viewed upon its external side : after Cheselden.

No. 1. The upper extremity or head of the bone. 2. The spine which gives attachment to the tendon of the biceps muscle. 3. The rough surface which gives attachment to the external lateral ligament of the knee-joint. 4, 4. The external surface of the shaft of the fibula. 5, 5. A part of the posterior surface of the shaft of the fibula. 6, 6. The lower extremity of the bone; its subcutaneous surface. 7. The point of the external malleolus. 8. The anterior or sharp border of the external malleolus. 9. The posterior border, deeply grooved for the passage of the tendons of the peronei muscles.

Fig. 4. A view of the articulating surface of the head of the tibia.

No. 1. The spinous process of the tibia. 2. The fossa in front of this process for the attachment of the anterior crucial ligament. 3. The fossa behind this process for the posterior crucial ligament. 4. The articulating surface for the internal condyle of the femur. 5. The articular surface for the external condyle of the femur.

Fig. 5. The inferior articulating surface of the tibia, seen from beneath.

No. 1. The anterior border of this extremity of the bone. 2. The surface which articulates with the astragalus. 3. The malleolus of the tibia. 4. The external surface of this malleolus, which articulates with the side of the astragalus. 5. The border of the surface, which articulates with the fibula.

Fig. 6. The tibia and fibula of the right leg, with their connecting ligaments : after Bourgery.

No. 1. The spinous process of the tibia. 2. The ligamentum patellæ. 3, 3. Portions of the capsular ligament of the knee-joint. 4. The shaft of the tibia. 5. The shaft of the fibula. 6. The articulation between the head of the fibula and the external tuberosity of the tibia. 7, 7. The interosseous membrane. 8. The aperture in the upper part of the interosseous membrane for the passage of the anterior tibial vessels. 9. The anterior tibio-fibular ligament of the inferior articulation between these two bones.

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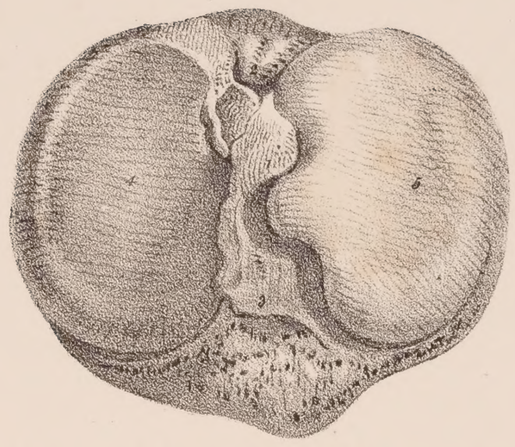
* Règne Animal, tom. i. p. 81.

Plate 26.

Fig. 1.

Fig. 4.



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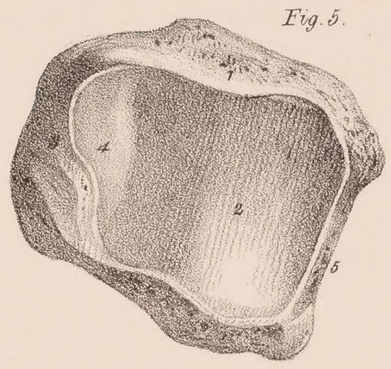

Fig. 6.

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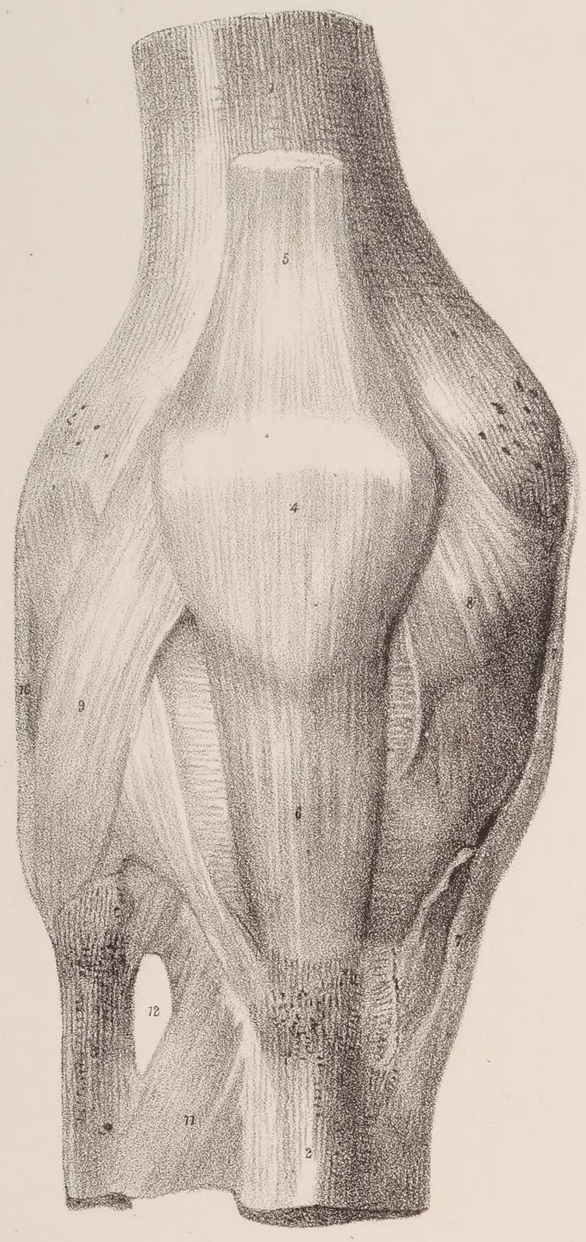

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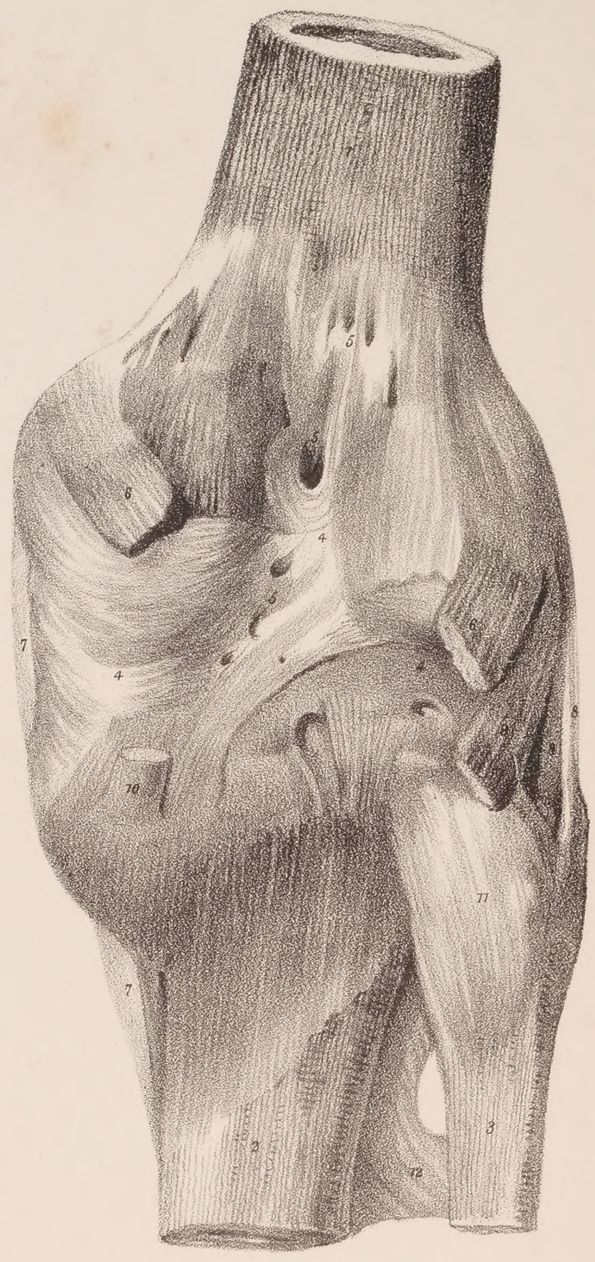

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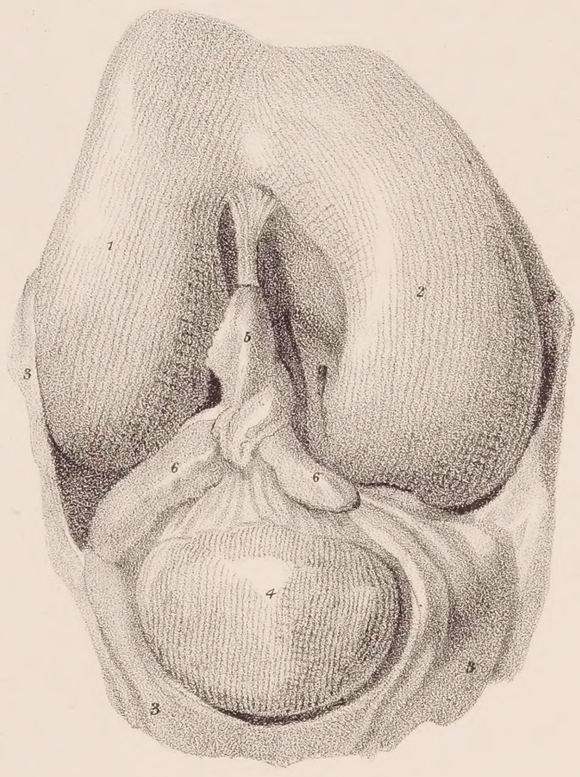

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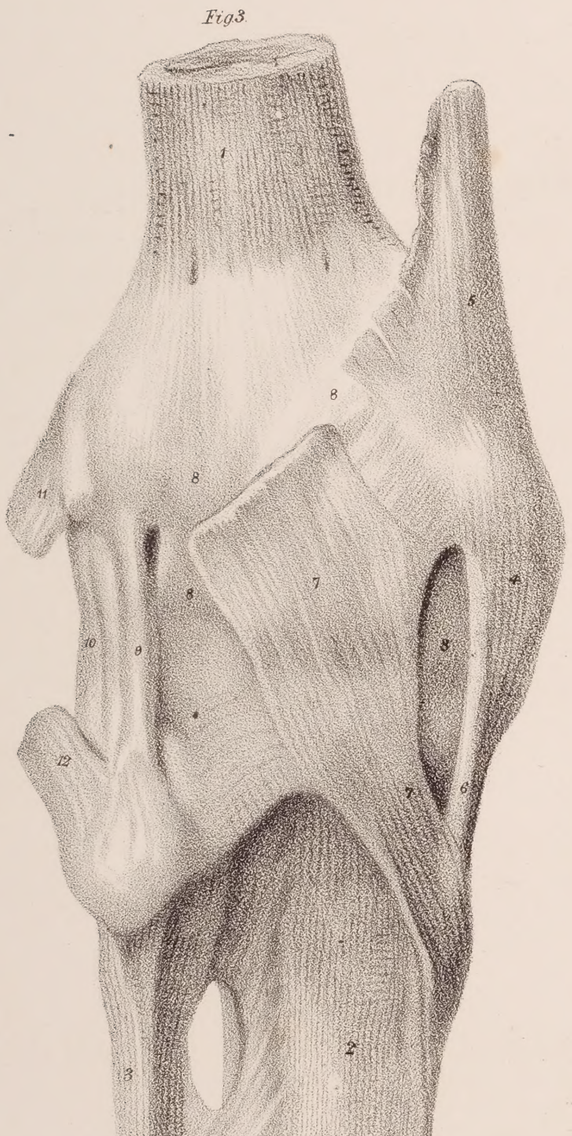

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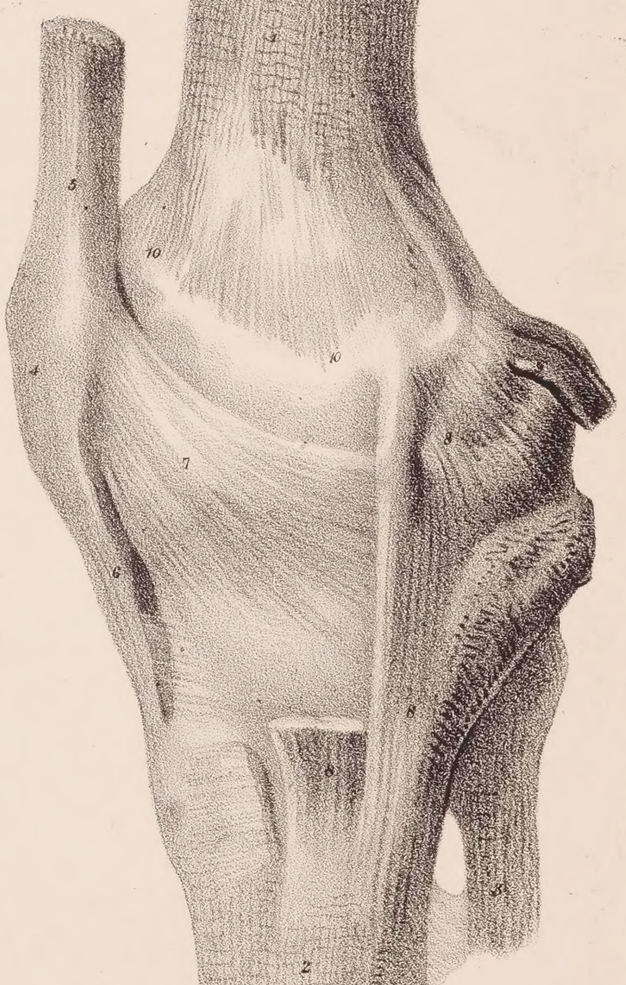


Fig. 7.

Fig. 6.

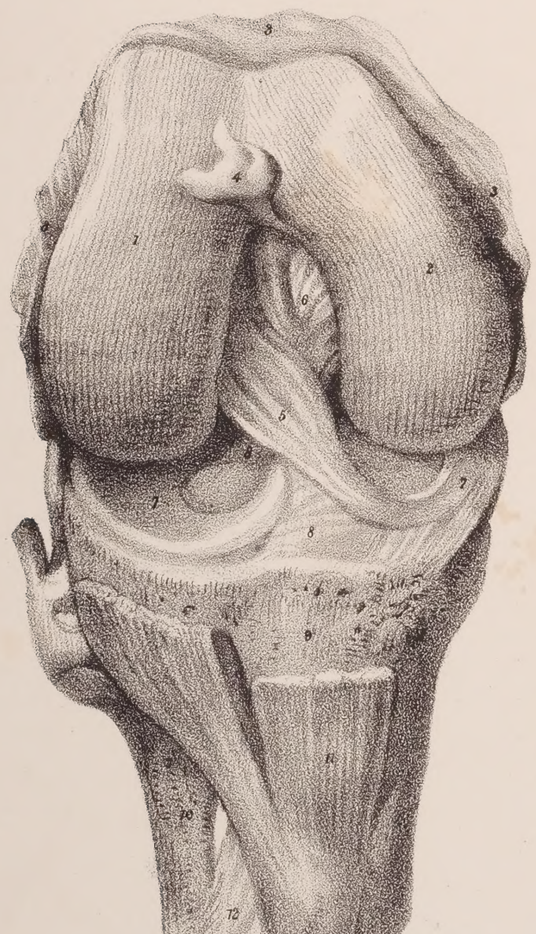
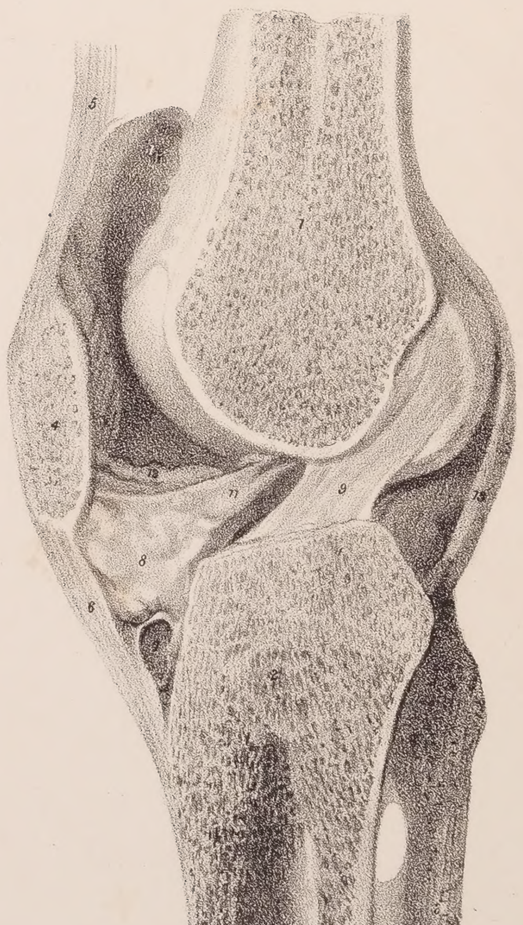


Fig. 8.



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as compared with that of other animals, or, with the moralist, reflect on his mental powers and high destination, we can scarcely refrain from saying, with the poet,

Sanctius his animal mentisque capacius altæ
Deerat adhuc, et quod dominari in cætera possit,
Natus est homo.

The Teeth.—The adult human subject is furnished with thirty-two teeth, sixteen in each jaw, arranged so that eight are placed on each side of the symphysis, in the upper and lower maxillæ. To facilitate their description, it is usual to consider a tooth as divisible into its *crown*, or that part projecting externally; the *root*, or that contained within the alveolus; and the *neck*, or part intermediate between the two. The root and central part of each tooth are composed of dense and hard osseous matter; and the projecting part, or crown, is, moreover, encased by a layer of white and excessively hard laminated substance, called enamel; at the superior and lateral parts of the crown the layer of enamel deposited upon it is thick, but gradually becomes thin at the neck, and disappears at the commencement of the root. The root and body of each tooth present a

PLATE XXVII.

The ligaments of the knee-joint.

Fig. 1. The ligaments of the front of the knee-joint: after Bourgery.

No. 1. The lower part of the femur. 2. The tibia. 3. The fibula. 4. The patella. 5. The tendon of the rectus muscle. 6. The ligamentum patellæ. 7, 7. The internal lateral ligament. 8. A ligamentous band passing inwards from the inner border of the patella, and expanding over the synovial membrane. 9. A similar band proceeding from the outer border of the patella. 10. The external lateral ligament. 11. The upper part of the interosseous membrane. 12. The aperture of transmission for the anterior tibial artery.

Fig. 2. The ligaments of the knee-joint, seen from behind: after Bourgery.

Nos. 1, 2, 3. The femur, tibia, and fibula. 4, 4. The posterior ligament,—ligamentum posticum Winslowii. 5, 5. Openings in this ligament for the passage of vessels and nerves. 6, 6. The two heads of the gastrocnemius muscle. 7, 7. The internal lateral ligament. 8, 8. The two external lateral ligaments. 9. The tendon of origin of the popliteus muscle. 10. The tendon of the semimembranosus muscle, cut short. 11. The posterior ligament of the peroneo-tibial articulation. 12. The interosseous ligament.

Fig. 3. The ligaments of the knee, seen upon the outer aspect of the joint: after Bourgery.

Nos. 1, 2, 3. The femur, tibia, and fibula. 4. The patella. 5. The common tendon of the quadriceps extensor muscle. 6. The ligamentum patellæ. 7, 7. Bands of ligament which strengthen the antero-lateral portions of the articulation. 8, 8. The synovial membrane. 9. The long external lateral ligament. 10. The short external lateral ligament. 11. The external head of the gastrocnemius. 12. The tendon of the biceps. 13. The interosseous membrane.

Fig. 4. The ligaments of the knee, seen upon the inner aspect of the joint: after Bourgery.

Nos. 1, 2, 3. The femur, tibia, and fibula. 4. The patella. 5. The tendon of the rectus muscle. 6. The ligamentum patellæ. 7. A ligamentous band, protecting the front of the articulation. 8, 8. The internal lateral ligament. 9. The internal head of the gastrocnemius muscle. 10, 10. The synovial membrane.

Fig. 5. The interior of the knee-joint, opened from the front and viewed previously to dissection: after Bourgery.

No. 1. The external condyle of the femur. 2. Its internal condyle. 3, 3. The synovial membrane, raised and turned back. 4. The internal surface of the patella. 5. The mucous ligament. 6, 6. The alar ligaments.

Fig. 6. The ligaments of the interior of the knee-joint, brought into view by dissecting away a part of the synovial membrane; the joint is viewed from the front: after Bourgery.

No. 1. The external condyle. 2. The internal condyle. 3, 3. The synovial membrane, turned back. 4. The mucous ligament, lifted upwards. 5. The anterior crucial ligament. 6, 6. The posterior crucial ligament. 7, 7. The semilunar fibro-cartilages. 8. The transverse ligament. 9. The tibia. 10. The fibula. 11. The lower part of the ligamentum patellæ. 12. The interosseous ligament. 13. The tendon of the biceps.

Fig. 7. The floor of the articulation of the knee-joint, showing the semilunar fibro-cartilages, and the inferior attachments of the crucial ligaments: after Bourgery.

No. 1. The anterior part of the head of the tibia. 2, 2. The external semilunar fibro-cartilage. 3, 3. The internal semilunar fibro-cartilage. 4. The anterior crucial ligament. 5. The posterior crucial ligament. 6. A part of the coronary ligament on the outer side of the joint. 7. The head of the fibula. 8, 8. Part of the internal lateral ligament.

Fig. 8. A vertical section of the knee-joint upon the middle line, showing the reflections of the synovial membrane of the articulation: after Bourgery.

No. 1. The femur. 2. The tibia. 3. The fibula. 4. The patella. 5. The tendon of the quadriceps extensor muscle. 6. The ligamentum patellæ. 7. The bursa of the ligamentum patellæ. 8. The articular mass of fat situated behind the ligamentum patellæ. 9. The anterior crucial ligament. 10. The pouch of synovial membrane situated between the tendon of the quadriceps extensor muscle and the front of the lower part of the femur. 11. The mucous ligament. 12. The alar ligament. 13. The posterior ligament.

cavity, lined by a membrane (pulpa dentis), on which the nutritious vessels and nerves ramify, after having entered through the foramina in the apices of the roots.

The teeth differ in size, form, manner of insertion, and mode of action, so that they are divisible into four sets, each of which has received a particular denomination, viz. incisores, cuspidati, bicuspidati, and molares.

The *incisor* or cutting teeth, (dentes incisores,) four in number in each jaw, are placed at the fore part of the mouth, forming the convex prominent part of the dental arch; their projecting part is wedge-shaped, the anterior and posterior surfaces being compressed, so that their free border is thin and sharp; this part of the tooth is convex in front, flat or concave behind, where it slopes upwards and forwards from a small elevation, which surmounts the neck. Those in the upper jaw, particularly the central pair, are larger than those of the lower. The roots of all are single, elongated, and tapering: the inserted as well as the projecting part of an incisor tooth is wedge-shaped, the former being compressed from side to side, the latter from before backwards.

The *canine* teeth (dentes cuspidati, canini) are two in number in each jaw, and come next in order after the lateral incisors. In these the projecting part is convex anteriorly, concave and sloping behind, and tapers towards its summit, where it ends in a blunted point: the root is longer and sinks deeper into the alveolus than that of any other teeth; it is single, conical, compressed at the sides, and marked by a slight groove, running its whole length from its apex to its summit. This is a trace or a rudiment of that division into processes which obtains in the molar teeth.

The *small molar* or bicuspid teeth, (dentes bicuspidati,) four in number in each jaw, are so named from usually having a divided root. They are intermediate in size as well as in situation between the cuspidati and molares. Their crown, compressed laterally where it is in apposition with the other teeth, is rounded on the external and internal sides, so that its depth from without inwards is greater than that of the incisores or cuspidati, whilst its breadth from side to side is less. The cutting extremities present two tubercles, one internal, the other external; in the lower jaw the internal tubercle is but very slightly prominent. A section of the neck presents an oval form; the root is single till near the apex, where it is usually bifid, particularly in the posterior bicuspidati; the groove at its sides is deeper than in the cuspidati.

The *large molar* or true grinding teeth (dentes molares) are larger and placed farther back than the others; the crown, or projecting part, is compressed from before backwards, as well as at the sides, so as to assume a cuboid form; its free surface, which is intended for trituration, is surmounted by four tubercles, separated by depressions, which so intersect one another as generally to assume a crucial form. There are six molares in each jaw when the set is completed: the first and second are the largest of all the teeth, and in the upper jaw are usually furnished with three roots, very seldom with four, whilst in the lower jaw there are but two. The disposition of the roots deserves attention. In the upper jaw two of the roots are placed external, and parallel in their direction, whilst the third projects inwards from them at a slight angle; in the lower jaw the roots are placed one anterior, the other posterior. The last of these molar teeth are the smallest, and, as they appear at an advanced period of life, are named *dentes sapientiæ*. The root is often single and tapering, but marked by two grooves, indicating, as it were, a tendency to separation; in the upper jaw we frequently find it bifid, with traces of a still further subdivision.

The dental formula for the adult is as follows:—incisors $\frac{4}{4}$, canine $\frac{2}{2}$, bicuspidati $\frac{4}{4}$, molares $\frac{6}{6}$.

What has been here stated applies altogether to the permanent teeth. The temporary or deciduous teeth which precede them are fewer in number, being twenty in all when complete; they are also smaller, and more delicate in their texture.

The formula for these is thus expressed:—incisors $\frac{4}{4}$, canine $\frac{2}{2}$, molares $\frac{4}{4}$.

The incisores and cuspidati are supplanted by permanent teeth of the same name: the bicuspid, which do not previously make their appearance, occupy the place of the temporary molares, so that the permanent molares will necessarily protrude at points farther back. The sockets into which the teeth are inserted are called alveoli; their form, number, and size being determined by that of the roots, which they lodge and receive; the alveolus being divided into two or three pits when the insertion of the tooth requires it, and being but a simple tapering fossa when a simple conformation obtains. The texture of the bone along the alveolar arches is porous and open, particularly in the transverse plates which separate the alveoli. In the natural state each of these cavities is lined by a prolonga-

tion of the periosteum, which invests the maxillary bones, and which extends into them as far as their apices, where it is reflected on the roots of the teeth so as to form a special investment for them.

The Thorax.—Into the composition of the thoracic portion of the skeleton enter the sternum and ribs, which are proper and peculiar to it, and the vertebræ, which are common to it and other parts.

The Sternum and Ensiform cartilage.—The sternum is situated in the median line, at the fore part of the thorax: it is flat and narrow, but not of equal width in its entire extent, being broad at its upper part, then narrowed somewhat, after which it widens a little; finally it becomes compressed and narrow where it joins the ensiform cartilage. Its direction is oblique from above downwards and forwards; which, together with the curve backwards in the dorsal part of the vertebral column, causes a considerable increase in the antero-posterior diameter of the thorax inferiorly. We have to consider successively its surfaces, extremities, and borders.

The anterior surface, slightly convex, and subjacent to the skin, gives attachment to the aponeurosis of the pectoralis major and to the sterno-mastoid muscles, and is marked by four transverse lines, indicating its original division into five pieces. The union between the first and second of these pieces (corresponding with the insertion of the second costal cartilages) is frequently cartilaginous even in adult age.

The posterior surface looks backwards, towards the cavity of the thorax, and gives attachment, superiorly, to the sterno-hyoideus and sterno-thyroideus muscles; inferiorly, to the triangularis sterni. Along the middle line it corresponds with the interval left by the divergence of the two pleuræ (anterior mediastinum).

The borders are thick, and marked on each side by seven angular depressions for the reception of the cartilages of the true ribs, which give them a notched or serrated appearance.

The superior extremity, broad and thick, is slightly excavated from side to side, and presents at each corner a depression for the reception of the sternal end of the clavicle.

The sternum, in early infancy, is divided into several pieces, but in adult age two only remain distinct. The first division of the sternum is larger and thicker than the other; its form is nearly square; its lateral margins, thin and oblique, present each an oblong depression, which receives the cartilage of the first rib; and at each inferior angle may be observed an articular half notch, which articulates with the second rib. The superior border is hollowed, and at the angles which bound it are the fossæ, which articulate with the clavicles, as has been already stated; the inferior is straight, and united to the extremity of the second piece.

The second piece, much longer than the first, is marked on its anterior surface by some transverse lines, which indicate its original division into separate portions. Both surfaces are nearly flat. The upper border is narrow, corresponding in breadth with the termination of the first bone, with which it is connected by cartilage. The lateral margins present each five notches for the reception of the cartilages of the five lower true ribs, and a half notch superiorly, which, with a similar depression in the first piece, forms a cavity for the second costal cartilage. The five inferior notches approach one another more closely in proportion as they are situated lower down, and part of the last is occasionally made up by the ensiform cartilage.

The inferior extremity of the sternum, thin and elongated, gives attachment to a cartilaginous appendix, called the *ensiform* or *xiphoid* (ξιφος, a sword; ειδος) cartilage, which in most cases remains in the cartilaginous state until an advanced period of life. It is sometimes bent forwards, sometimes in the opposite direction, and sometimes pierced by a hole at its centre. Its form varies considerably in different individuals: it gives attachment to the aponeuroses of the abdominal muscles.

Articulations.—This bone articulates by its sides with the true ribs,—by its upper angles with the clavicles, and by its lower end with the ensiform cartilage. When examined at an early period, it exhibits usually eight or nine ossific centres. When sawed across, the sternum presents a considerable quantity of loose spongy texture in its interior, with a very thin lamella of compact tissue on its outside;—hence it is very light.

The Ribs and their cartilages.—The *ribs* (costæ) extend from the dorsal portion of the vertebral column to the sternum, forming arches, which enclose the lateral parts of the thorax. They are twelve in number at each side, of which the seven superior pairs, which are united by means of cartilaginous prolongations to the sternum, are called *sternal* or *true ribs;* the remaining five, which are not prolonged to the sternum, being denominated *asternal* or *false ribs.*

The ribs do not arch uniformly from the vertebral column towards the sternum: the greater

number consist of parts of two circles or arches of different diameters, the anterior being much the larger. Thus the rib, directed at first backwards from its connexion with the bodies of the vertebræ, reaches and is supported by the transverse process (which in the dorsal region is inclined backwards); after leaving the extremity of this process it turns abruptly outwards, and finally is directed forward towards the sternum.

In their length, breadth, and direction, these bones present several varieties. From the first to the eighth their length successively increases, whilst from the ninth to the twelfth they gradually decrease, so that the last is very little longer than the first.

Their breadth, considered in the whole series, diminishes gradually from the first to the twelfth; but in each rib it is greatest towards its sternal extremity.

As to their direction in reference to the vertebral column, the first forms almost a right angle with it, and the succeeding ones gradually incline downwards, so that their anterior extremity is lower than the posterior. The body of all the ribs, except the first, is, as it were, twisted on itself, so that their two extremities cannot be made to rest at the same time on a plain surface.

These bones present two surfaces, two borders, and two extremities.

The external surface is convex and smooth. The internal is concave, and corresponds with the pleura.

PLATE XXVIII.

The bones of the foot in their articulated position and in the fœtal state.

Fig. 1. The right foot, seen upon its upper surface: after Cheselden.

No. 1. The superior articular surface of the astragalus. 2. The anterior portion of that bone. 3, 3. The os calcis. 4. The commencement of the groove in which the interosseous ligament is lodged. 5. The scaphoid bone. 6. Its tuberosity. 7. The internal cuneiform bone. 8. The middle cuneiform bone. 9. The external cuneiform bone. 10. The cuboid bone. 11, 11. The metatarsal bones. 12, 12. The first row of phalanges. 13, 13. The second row of phalanges. 14, 14. The last phalanges.

Fig. 2. The under surface of the same foot: after Cheselden.

No. 1. The under part of the os calcis. 2. The posterior tuberosity of the os calcis. 3. The internal tuberosity of that bone. 4. Its external tuberosity. 5. The concave surface of the os calcis, which supports the tendons and vessels which pass into the sole of the foot. 6. The groove in which the tendon of the flexor longus digitorum muscle plays. 7. The side of the astragalus. 8. The rounded head of the astragalus. 9. The under surface of the scaphoid bone. 10. The tuberosity of the scaphoid bone. 11. The internal cuneiform bone. 12, 12. The apex of the middle cuneiform bone. 13. The external cuneiform bone. 14. The cuboid bone. 15, 15. The groove in this bone for the tendon of the peroneus longus muscle. 16. The metatarsal bone of the great toe. 17. The tubercle at its base which gives insertion to the tendon of the peroneus longus. 18, 18. The remaining metatarsal bones. 19. The tubercle on the base of the metatarsal bone of the little toe. 20, 20. The first row of phalanges. 21, 21. The second row of phalanges. 22, 22. The last phalanges.

Fig. 3. The inner border of the left foot: after Cheselden.

No. 1. The superior articular surface of the astragalus. 2. The lateral surface, which articulates with the inner malleolus of the tibia. 3. The inner and concave side of the os calcis. 4. The posterior tuberosity of the os calcis. 5. The internal tuberosity of that bone. 6. The process which supports the anterior portion of the astragalus. 7. The anterior part of the astragalus. 8. Its articular surface. 9. The scaphoid bone. 10. Its tuberosity. 11. The internal cuneiform bone. 12. A smooth facet which gives attachment to the tendon of the tibialis anticus muscle. 13. The base of the middle cuneiform bone. 14. The metatarsal bone of the great toe. 15, 15. The metatarsal bones of the other toes. 16. The first phalanx of the great toe. 17. The last phalanx of the same toe.

Fig. 4. The left foot, seen upon its outer side: after Bourgery.

No. 1. The superior articular surface of the astragalus. 2. The triangular lateral surface which articulates with the external malleolus. 3. The anterior portion of the astragalus. 4, 4. The os calcis. 5. Its posterior tuberosity. 6. Part of the smooth surface which supports the bursa of the tendo Achillis. 7. The external tuberosity of the os calcis. 8. The smooth pulley-like surface against which the tendons of the peronei muscles play. 9. The cuboid bone. 10. A notch upon the cuboid, which marks the commencement of the groove for the tendon of the peroneus longus muscle. 11. The scaphoid bone. 12. The external cuneiform bone. 13. The middle cuneiform bone. 14, 14. The metatarsal bones. 15. The tuberosity at the base of the metatarsal bone of the little toe. 16, 16. The first row of phalanges. 17, 17. The second row of phalanges. 18, 18. The last phalanges.

Fig. 5. A single toe, showing the four bones which enter into its formation: after Cheselden.

No. 1. The metatarsal bone. 2. A smooth surface by which the base of this bone articulates with the adjoining bone. 3. The head of the metatarsal bone. 4. The first phalanx. 5. Its base. 6. Its head. 7. The second phalanx. 8. The third and last phalanx.

Fig. 6. The two sesamoid bones of the metatarso-phalangeal articulation of the great toe.

Fig. 7. The foot of a fœtus at an early period: after Cheselden. The tarsus is wholly cartilaginous, and the metatarsal bones and phalanges only partly developed.

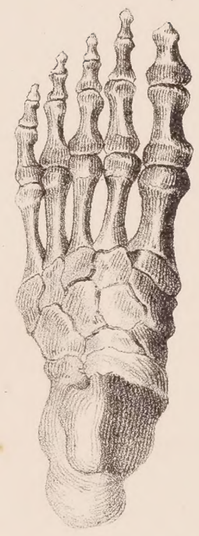
Fig. 8. The foot of a fœtus at a more advanced period: after Cheselden.

Fig. 2.

Fig. 7.

Fig. 6.

Fig. 8.



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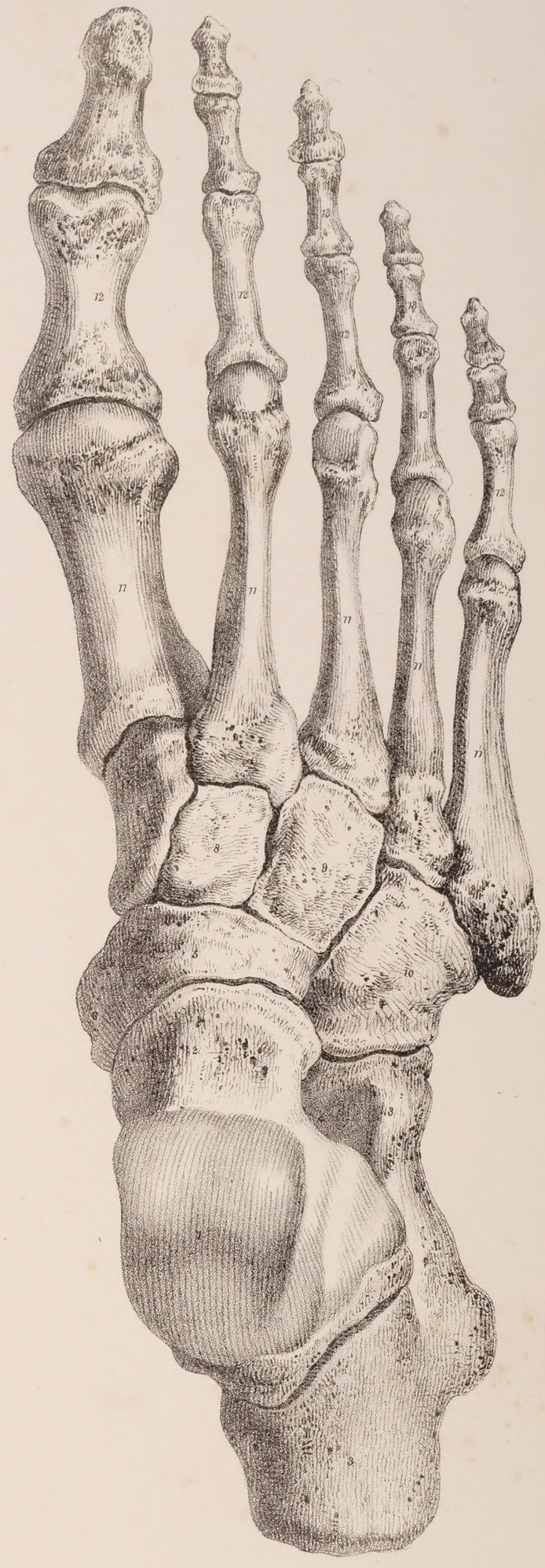

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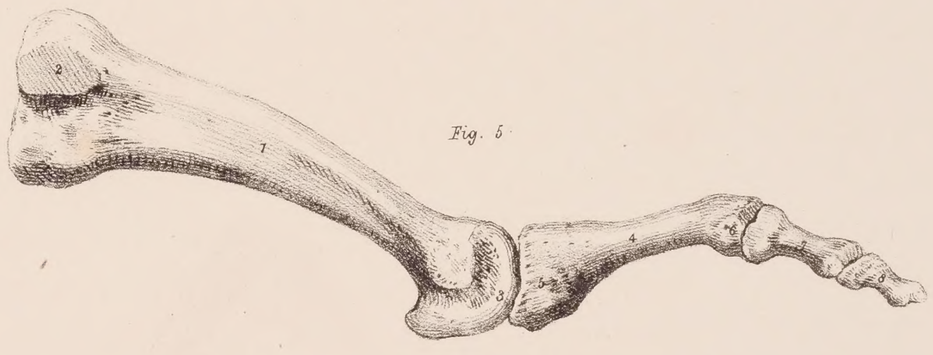

Fig. 3.

Fig. 4.

W. Fairland, lith.

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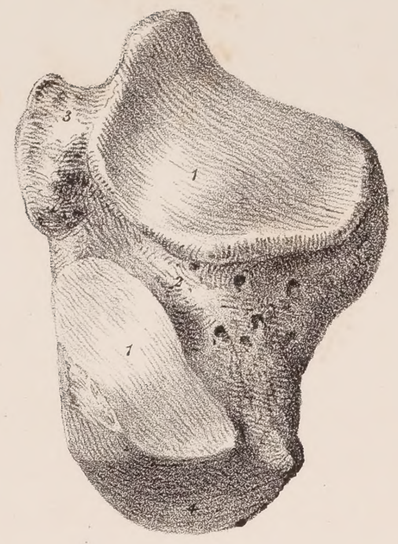
Plate 29

Fig 1

Fig 2



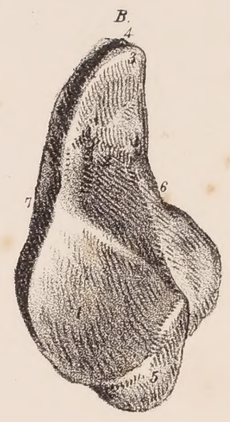


Fig 5

Fig 3

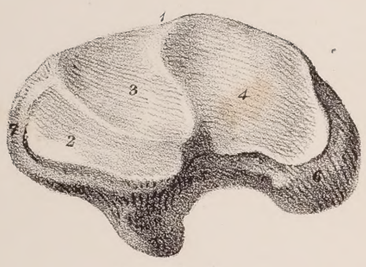


Fig 4

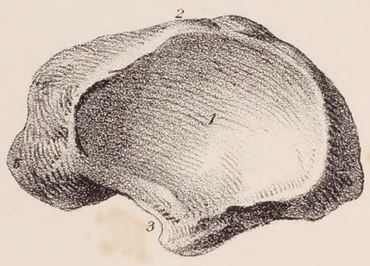


Fig 8

Fig 6

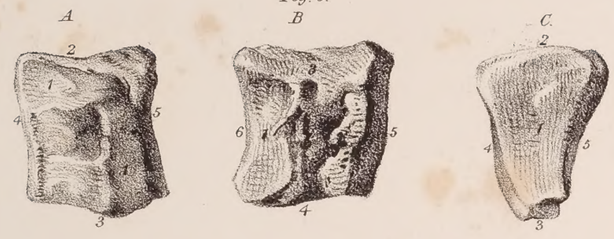


Fig 7

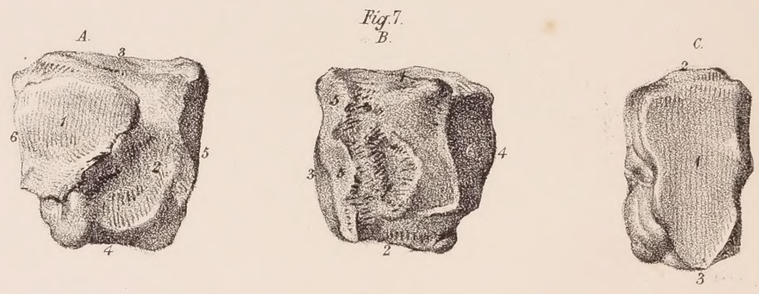


Fig 10

Fig 13

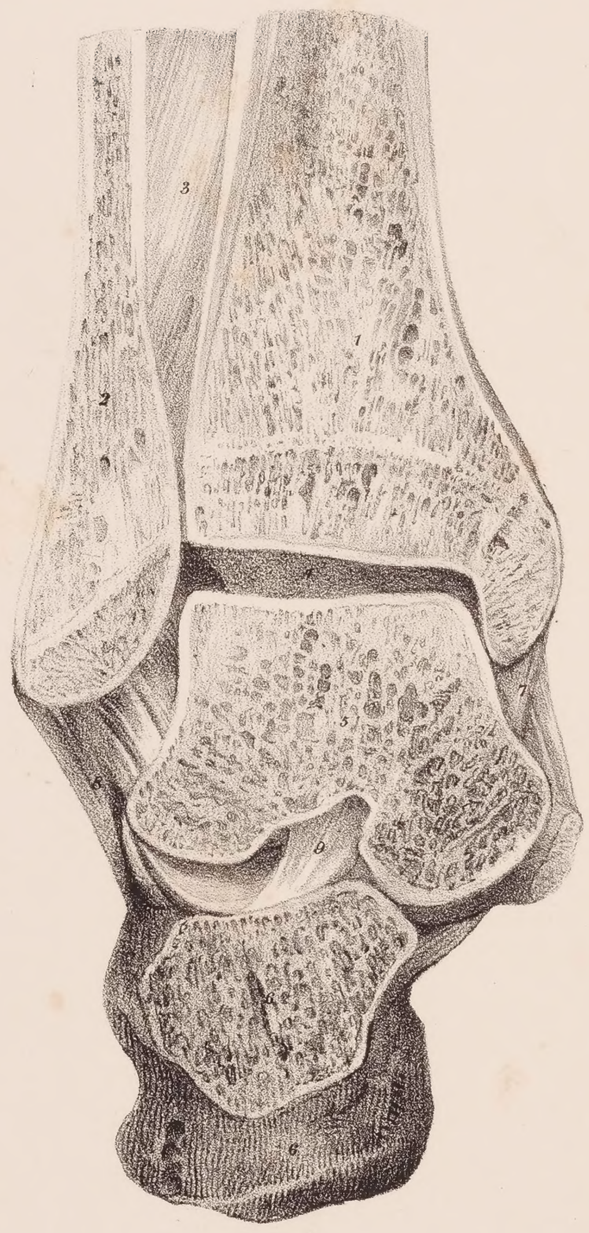


Fig 9

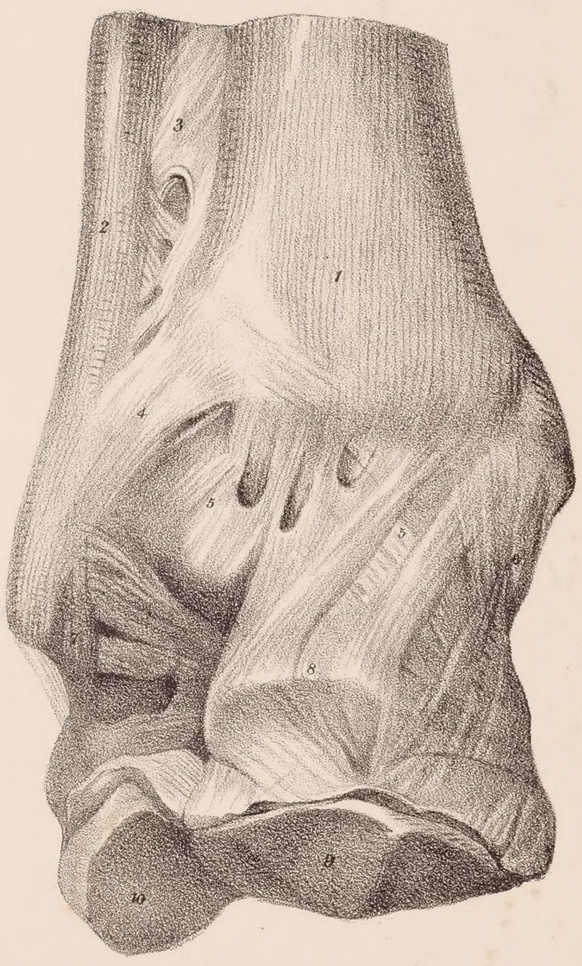


Fig 12

Fig 11

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The superior border, smooth and rounded, gives attachment to the intercostal muscles; the inferior is marked on its inner aspect by a groove, which is commonly said to be for the lodgment of the intercostal vessels, and also gives attachment to the intercostal muscles.

The posterior extremity, somewhat rounded and thicker than the other parts of the rib, and hence denominated its *head*, presents (except in the instances to be presently stated) two articular

PLATE XXIX.

The ligaments of the ankle, and bones of the tarsus.

Fig. 1. The os calcis of the right foot,—its upper surface.—No. 1. The posterior tuberosity. 2, 2. The two surfaces which articulate with the under part of the astragalus. 3. The groove for the interosseous ligament. 4. The outer border. 5. The cuboid surface.

Fig. 2. The under part of the astragalus of the right foot.—Nos. 1, 1. The surfaces which articulate with the os calcis. 2. The groove for the interosseous ligament. 3. The groove for the tendon of the flexor longus pollicis muscle. 4. The rounded head of the astragalus.

Fig. 3. The scaphoid bone of the right foot,—its anterior surface.—No. 1. The upper border. 2. The facet which articulates with the external cuneiform bone. 3. The facet for the middle cuneiform bone. 4. The facet for the internal cuneiform bone. 5. The under surface. 6. The tuberosity. 7. The broad extremity.

Fig. 4. The posterior surface of the scaphoid bone of the right foot.—No. 1. The concave surface which articulates with the head of the astragalus. 2. The upper border. 3. The lower border. 4. The broad extremity. 5. The tuberosity.

Fig. 5. The internal cuneiform bone of the right foot.—A. The anterior border of this bone. No. 1. Its upper extremity. 2. Its lower extremity. 3. The outer surface. 4. The inner or subcutaneous surface. 5. The facet which gives attachment to the tendon of the tibialis anticus muscle. 6. The metatarsal surface. B. The posterior border of the same bone.—No. 1. The facet which articulates with the scaphoid bone. 2. The facet which articulates with the middle cuneiform bone. 3. A small facet for articulation with the base of the metatarsal bone of the second toe. 4. The apex of the bone. 5. Its base. 6. Its external surface. 7. Its internal or subcutaneous surface.

Fig. 6. The middle cuneiform bone of the right foot.—A. The internal surface of this bone. Nos. 1, 1. The facet which articulates with the internal cuneiform bone. 2. The upper surface of the bone. 3. Its inferior border. 4. Its anterior border. 5. Its posterior border.—B. The same bone, viewed upon its external aspect. No. 1. The facet which articulates with the external cuneiform bone. 2. The rough surface for attachment to interosseous ligaments. 3. The upper surface of the bone. 4. The inferior border. 5. The anterior border. 6. The posterior border.—C. The posterior border of the same bone. No. 1. The facet which articulates with the scaphoid bone. 2. The base of the bone. 3. Its inferior border. 4. The internal surface. 5. Its external surface.

Fig. 7. The external cuneiform bone of the right foot.—A. The external surface of this bone. No. 1. The facet for articulation with the cuboid bone. 2. A rough surface for the attachment of the interosseous ligaments. 3. The superior border of the bone. 4. Its inferior border. 5. The anterior border of the bone. 6. Its posterior border.—B. The internal surface of the same bone. No. 1. The upper surface of the bone. 2. Its inferior border. 3. The anterior border. 4. The posterior border. 5, 5. The metatarsal surface. 6. The facet which articulates with the middle cuneiform bone.—C. The anterior border of the same bone. No. 1. The facet which articulates with the base of the metatarsal bone of the third toe. 2. The dorsal surface of the bone. 3. The inferior border. 4, 4. The facet which articulates with the base of the metatarsal bone of the second toe. 5. The outer surface of the bone.

Fig. 8. The cuboid bone of the right foot.—No. 1. Its dorsal surface. 2. Its plantar surface. 3. The peroneal groove. 4. A smooth facet for a bursa mucosa. 5. The outer border of the bone. 6. The anterior or metatarsal surface. 7. The posterior surface of the cuboid bone.

Fig. 9. The ankle-joint, seen upon its anterior aspect: after Bourgery.—No. 1. The tibia. 2. The fibula. 3. The interosseous ligament. 4. The anterior ligament of the inferior peroneo-tibial articulation. 5, 5. The anterior ligament of the ankle-joint. 6. The internal lateral ligament. 7. The external lateral ligament 8. A prominence formed by the astragalus. 9. The scaphoid bone. 10. The cuboid bone.

Fig. 10. The ankle-joint, viewed from behind, after Bourgery.—No. 1. The tibia. 2. The fibula. 3. The interosseous membrane. 4. The posterior ligament of the inferior peroneo-tibial articulation. 5. The groove for the peronei tendons. 6. The groove for the tendons of the flexor longus digitorum, and the tibialis posticus muscle. 7. The posterior ligament. 8. The transverse ligament. 9. The internal lateral ligament. 10. The external lateral ligament,—its middle fasciculus. 11, 11. Its posterior fasciculi. 12. The groove upon the astragalus for the tendon of the flexor longus pollicis muscle. 13. The posterior tuberosity of the os calcis.

Fig. 11. The ankle-joint, viewed from the internal aspect: after Bourgery.—No. 1. The tibia. 2. The fibula. 3, 3. The internal lateral ligament. 4. The scaphoid bone. 5. A groove for the tendon of the tibialis posticus muscle. 6. The groove for the tendons of the flexor longus digitorum and flexor longus pollicis muscles. 7, 7. The os calcis. 8. The tendo Achillis.

Fig. 12. The ankle-joint, viewed upon its external aspect: after Bourgery.—No. 1. The tibia. 2. The fibula. 3. The anterior ligament. 4. The anterior fasciculus of the external lateral ligament. 5. Its middle fasciculus. 6. Its posterior fasciculus. 7. The scaphoid bone. 8, 8. The os calcis. 9. The tendo Achillis.

Fig. 13. A vertical section of the ankle-joint, showing the cavity of the articulation and the interosseous ligament of the calcaneo-astragaloid articulation: after Bourgery.—No. 1. The tibia. 2. The fibula. 3. The interosseous ligament. 4. The cavity of the ankle-joint. 5. The astragalus. 6, 6. The os calcis. 7. The internal lateral ligament of the ankle. 8. The external lateral ligament. 9. The calcaneo-astragaloid interosseous ligament.

faces (separated by a slight ridge) which articulate with the corresponding small surfaces on the bodies of the dorsal vertebræ; the head is supported by a narrow round part, or *neck*, terminated externally by a tubercle, which is smooth in one part for its articulation with the transverse process of the lower of the two vertebræ to which the head is connected, and rough in the other for the insertion of the posterior costo-transverse ligament.

The anterior extremity is broad, flat, and hollowed at its tip into an oval pit, into which is implanted the costal cartilage.

Between the tuberosity and the most convex part of the body of each rib is a rough line, marking what is termed its *angle*. The distance of the angle from the tuberosity increases gradually from the second to the eleventh inclusive. In the last it is not perceptible: in the first it is not distinguishable from the tuberosity.

The first two and the last two ribs present some peculiarities deserving of notice.

The *first* rib is shorter and broader than either of the succeeding ones, its direction is nearly horizontal; its body not being twisted, as is the case in other ribs, it lies evenly when placed on a plain surface. One surface looks upwards, and is marked by two very slight depressions (over which slide the subclavian vessels), and an intervening roughness, sometimes well marked, which indicates the attachment of the scalenus anticus muscle. The other surface looks downwards, towards the cavity of the thorax. The external border, convex and rounded, is surmounted by the tuberosity; the internal is thin, and forms the margin of the superior aperture of the thorax. The anterior extremity is broad and thick; the *head*, which articulates with the first dorsal vertebra, is small, presents an undivided articular surface, and is supported by a slender neck.

The *second* is longer than the first, and presents externally a prominent line for the attachment of the serratus magnus; its internal surface is somewhat grooved posteriorly.

The *eleventh* has no groove on its inferior border, nor a tubercle, as it is not articulated with the transverse process; its angle is scarcely perceptible, and the head has but one articulating surface.

The *twelfth* differs little from the preceding one, except in being shorter; it has neither angle, tubercle, nor groove, and as its anterior extremity, which is pointed, seems loose and unattached, it is called the floating rib.

The ribs grow from three osseous points; one in the body, one in the head, the third being at the tuberosity.

Costal cartilages.—These cartilages are twelve in number, like the ribs, of which they form the elastic continuation; their breadth diminishes gradually from the first to the last, whilst the length increases as far as to the seventh, after which it becomes less in each succeeding one. Their line of direction also varies considerably. The second is horizontal, the first descends a little, and all the rest ascend more and more as they are situated lower down. The external or costal extremity, convex and unequal, is implanted into the end of the corresponding rib. The internal extremities of the cartilages of the true ribs, smaller than the external, and somewhat pointed, are articulated with corresponding angular surfaces on the sides of the sternum; each of the cartilages of the first three false ribs, becoming slender towards its extremity, is attached to and blended with the lower border of that which is next above it; in the two last it is pointed, and unattached.

Attachment of muscles.—The two layers of intercostals, to the contiguous borders of all the ribs; the scaleni, to the first and second; the pectoralis major, to the cartilages of the true ribs, except the first; pectoralis minor, to the bodies of the third, fourth, and fifth; rectus abdominis, to the cartilages of the last three true ribs and ensiform cartilage; obliquus externus, to the last three true ribs and all the false; the internal oblique and transversalis, to the cartilages of the four or five false ribs; the diaphragm, to the ensiform cartilage, and to those of the last six ribs.

The serratus magnus, to the nine superior ribs; latissimus dorsi, to the four inferior; serratus posticus superior, to the third, fourth, and fifth true ribs; serratus posticus inferior, to the three last; sacro-lumbalis, to the angles of all the ribs; levatores costarum, a little beyond the tuberosities.

Bones of the superior extremity.—The upper extremity consists of the shoulder, the arm, the fore-arm, and the hand. The shoulder consists of the scapula and clavicle; the arm, of the humerus; the fore-arm, of the radius and ulna; and the hand, of the carpus, metacarpus, and fingers.

Scapula.—This bone [plate XVI.] is placed upon the upper and back part of the thorax, occupies the space from the second to the seventh rib, and forms the posterior part of the shoulder.

Its form is irregularly triangular and flat. It presents for examination two surfaces, three borders, and three angles.

The anterior surface, called also *fossa subscapularis*, looks towards the ribs, is triangular, slightly concave, intersected by prominent lines directed from within outwards and upwards, and therefore crossing the direction of the ribs.

The posterior surface (*dorsum scapulæ*) is divided into two parts, but unequally, by a prominent ridge (the spine): of these, the superior one is called fossa supra-spinata; the inferior, fossa infra-spinata.

Of the spine.—The spine of the scapula is a prominent ridge of bone, flattened from above downwards, commencing at the posterior border of the scapula, with a smooth flat triangular surface, from which it becomes gradually more elevated as it proceeds forwards, until it terminates in an elongated process (acromion), which surmounts the shoulder-joint. The form of the spine considered by itself apart from the acromion is triangular; hence we have to notice its two surfaces and three borders. Its superior surface is concave, and, conjointly with the superior part of the dorsum of the scapula, forms the fossa supra-spinata. The inferior surface is irregularly triangular, constitutes part of the infra-spinous fossa, and in its middle may be observed a small foramen for a nutritious vessel. On the projecting border of the spine, which is rough and broad, may be noticed two margins, of which the superior one gives attachment to the trapezius, the inferior to the deltoid muscle,—the intervening edge is subcutaneous. The anterior or attached border, or base, is united with the dorsum of the bone. The external border, which is short, round, and somewhat concave, approaches the neck of the bone, and is continuous with the under surface of the acromion.

Of the acromion process.—This considerable eminence is flattened in the direction opposite to that of the spine, and, projecting outwards and forwards, forms the summit of the shoulder-joint; hence its designation (ακρον, a summit; ωμος, the shoulder). Its posterior and upper surface, convex and somewhat rough, is subcutaneous; the anterior and inferior one, concave and smooth, is in relation with the supra-spinatus muscle, and overlies the capsular ligament of the shoulder-joint; the superior border presents, anteriorly, a narrow oval surface for its articulation with the external extremity of the clavicle, and its summit affords attachment to the coraco-acromion ligament.

The *fossa supra-spinata*, wider towards its vertebral than the other extremity, is filled up by the supra-spinatus muscle. The *fossa infra-spinata*, much larger than the preceding, is convex in the middle, somewhat concave, or rather grooved, inferiorly. Between the latter part and the axillary border is a slightly raised and elongated ridge, which extends from the glenoid cavity obliquely downwards to within an inch of the posterior angle of the bone, where it subsides into a flat and nearly quadrilateral surface. This latter part it is that gives origin to the teres major muscle, and over it slides the latissimus dorsi. Along the upper and rounded part arise the fibres of the teres minor; whilst the line of division between them marks the attachment of an aponeurosis, common to these muscles and to the infra-spinatus, which occupies the remainder of the fossa.

Of the three *borders* of the scapula, or costæ (as they are sometimes called), the *superior* is the shortest; at its outer part is situated a lunated notch, (lunula; incisura semi-lunaris,) which is converted into a foramen by a ligament, and is traversed sometimes by the supra-scapular vessels and nerve, but usually by the nerve alone. In front of this opening it is surmounted by the *coracoid* process, which, being thick, elongated, and curved on itself, is named from some fancied resemblance to a crow's beak, (κοραξ, a crow; ειδος, like). This process, superiorly convex and unequal, gives attachment to the coraco-clavicular ligament; anteriorly to the pectoralis minor muscle; posteriorly to the coraco-acromion ligament; and by its extremity to the biceps and coraco-brachialis muscles. The *posterior*, or vertebral border, named also the "base" of the scapula, is the longest of the three; superiorly it approaches to the vertebral column, inferiorly it is more removed from it. The portion of this border which is above the spine will be observed to incline a little outwards. For the purpose of more easily assigning the attachments of the several muscles which are connected with it, we may regard it, though very thin, as divisible into two margins, with an inter-space; these are stated in the enumeration of the muscular attachments. The *axillary* border is inclined downwards and backwards from the lower margin of the glenoid cavity to the inferior angle of the bone; hence it is named the *inferior costa* of the scapula. It is of considerable thickness, being surmounted posteriorly by the ridge above noticed as giving origin to the teres minor. The edge itself presents a shallow groove running along the greater part of its extent. It corresponds with the lower border of the sub-scapular muscle. For about an inch beneath the glenoid fossa there is a well-marked linear impression, which gives origin to the long head of the triceps muscle.

The postero-superior *angle* is formed by the junction of the base with the superior costa of the scapula; it is somewhat inclined outwards. The inferior angle is placed at the union of the base with the axillary or inferior border of the bone; upon it may be observed an elongated flat surface which gives origin to the teres major, and over which slides the latissimus dorsi muscle. At the convergence of the superior and inferior borders may be observed a narrow constricted part, denominated the *neck* (cervix scapulæ). The neck is bounded by a slightly-raised rim, which gives attachment to the fibrous capsule of the shoulder-joint; and finally the rim surrounds the articular surface of the bone, which is called the *glenoid* cavity (γληνη, a superficial cavity; ειδος). This is a shallow, oval depression, broader below than above, covered with cartilage in the fresh state, and deepened somewhat by a fibro-cartilaginous margin, which passes round it from the long tendon of the biceps muscle, whose origin is at its upper margin; its greatest diameter is perpendicular, its direction outwards and forwards. In this last respect, however, it varies considerably; for, during the more extended motions of the humerus, the scapula is made to turn, as it were, on a pivot driven through the centre of its dorsum, by which means the glenoid cavity is kept constantly in apposition with the head of the humerus, which is the chief security against its dislocation.

The scapula articulates by its glenoid cavity with the humerus, and by the acromion process with the clavicle; it affords attachment to the following muscles:—

The sub-scapular fossa (the anterior or costal surface of the bone), to the sub-scapularis muscle. Posterior or dorsal surface,—the spine (by its border and the acromion) superiorly to the trapezius, inferiorly to the deltoid: the fossa supra-spinata, by its posterior two-thirds, to the muscle of the same name: the fossa infra-spinata, in the greater part of its extent, to the infra-spinatus; by a slight oblique line situated near the inferior angle, to the aponeurosis common to the infra-spinatus, teres minor, and teres major; by a narrow rounded surface, near the axillary border, to the teres minor; by the flat surface, at its inferior angle, to the teres major.

PLATE XXX.

The ligaments of the foot.

Fig. 1. The superficial ligaments of the dorsum of the foot: after Bourgery.—No. 1. The astragalus. 2. The os calcis. 3. The tendo Achillis. 4, 4. Calcaneo-astragaloid ligaments. 5, 5. Dorsal ligaments of the tarsus. 6. The tendon of the peroneus longus. 7. The tendon of the tibialis posticus. 8. The internal cuneiform bone. 9. The external cuneiform bone. 10. The cuboid bone. 11, 11. Tarso-metatarsal ligaments. 12, 12. Metatarsal ligaments. 13, 13. Lateral ligaments of the metatarso-phalangeal articulation 14, 14. A band of the deep fascia of the foot. 15. A metatarso-phalangeal articulation laid open. 16, 16. The transverse ligaments. 17, 17. The lateral ligaments of the phalangeal articulations. 18. The tendon of the extensor proprius pollicis. 19. One tendon of the extensor communis digitorum.

Fig. 2. Deep ligaments of the dorsum of the foot: after Bourgery.—No. 1. The astragalus. 2, 2. The os calcis. 3, 3. Ligaments connecting these two bones. 4. The tendo Achillis. 5. The scaphoid bone. 6. The articulation between the astragalus and the scaphoid bone. 7. A calcaneo-scaphoid ligament. 8, 9, 10. The three cuneiform bones. 11. The cuboid bone. 12, 12. The scaphoido-cuneiform articulation. 13, 13. Ligaments of the cuneiform bones. 14. The cuboido-cuneiform articulation. 15. A calcaneo-cuboid ligament. 16, 16. The tarso-metatarsal articulations. 17, 17. The lateral metatarsal articulations. 18, 18. The metatarsal bones.

Fig. 3. The superficial ligaments of the sole of the foot: after Bourgery.—No. 1, 2. The os calcis. 3. The groove for the tendon of the flexor longus pollicis. 4, 4. The calcaneo-scaphoid ligament. 5. The tendon of the tibialis posticus. 6, 7. Prominences caused by the scaphoid and the internal cuneiform bones. 8, 8. The greater calcaneo-cuboid ligament. 9, 9. The deep calcaneo-cuboid ligament. 10, 10. The tendon of the peroneus longus. 11, 11. Inferior tarso-metatarsal ligaments. 12, 12. Meta-tarso-metatarsal ligaments. 13, 13. The metatarsal bones. 14, 14. A part of the plantar fascia. 15, 15. Ligamentous bands which serve to retain the tendons of the flexor muscles. 16, 16. The transverse ligament of the metatarso-phalangeal articulation. 17, 17. The inferior ligament of this articulation. 18, 18. Lateral ligaments of the metatarso-phalangeal articulations. 19. One of the metatarso-phalangeal articulations laid open. 20, 20. Lateral phalangeal ligaments. 21, 21. Inferior phalangeal ligaments. 22. One of the phalangeal articulations laid open.

Fig. 4. The deep ligaments of the sole of the foot: after Bourgery.—Nos. 1, 1. The os calcis. 2. The groove for the tendon of the flexor longus pollicis. 3, 3. The inferior calcaneo-scaphoid ligament. 4. The deep calcaneo-cuboid ligament. 5, 5. Cuboido-cuneiform ligament. 6, 6. Metatarso-metatarsal ligaments. 7. The inferior tarso-metatarsal ligament of the great toe. 8. The tendon of the peroneus longus muscle. 9, 9. Metatarsal bones.

Fig. 5. A vertical section of the foot, showing the interosseous ligaments: after Bourgery.—No. 1. The tibia. 2. The astragalus. 3, 3. The interior of the ankle-joint. 4. The anterior ligament of this articulation. 5. The posterior ligament. 6. The os calcis. 7. The tendo Achillis. 8. The scaphoid bone. 9. The calcaneo-astragaloid interosseous ligament. 10. Part of the calcaneo-scaphoid ligament. 11. The internal cuneiform bone. 12. The metatarsal bone of the great toe. 13, 13. The phalanges of the great toe. 14. One of the sesamoid bones. 15. Metatarsal bones. 16. The great or superficial calcaneo-cuboid bone.

Plate 30.

Fig 1

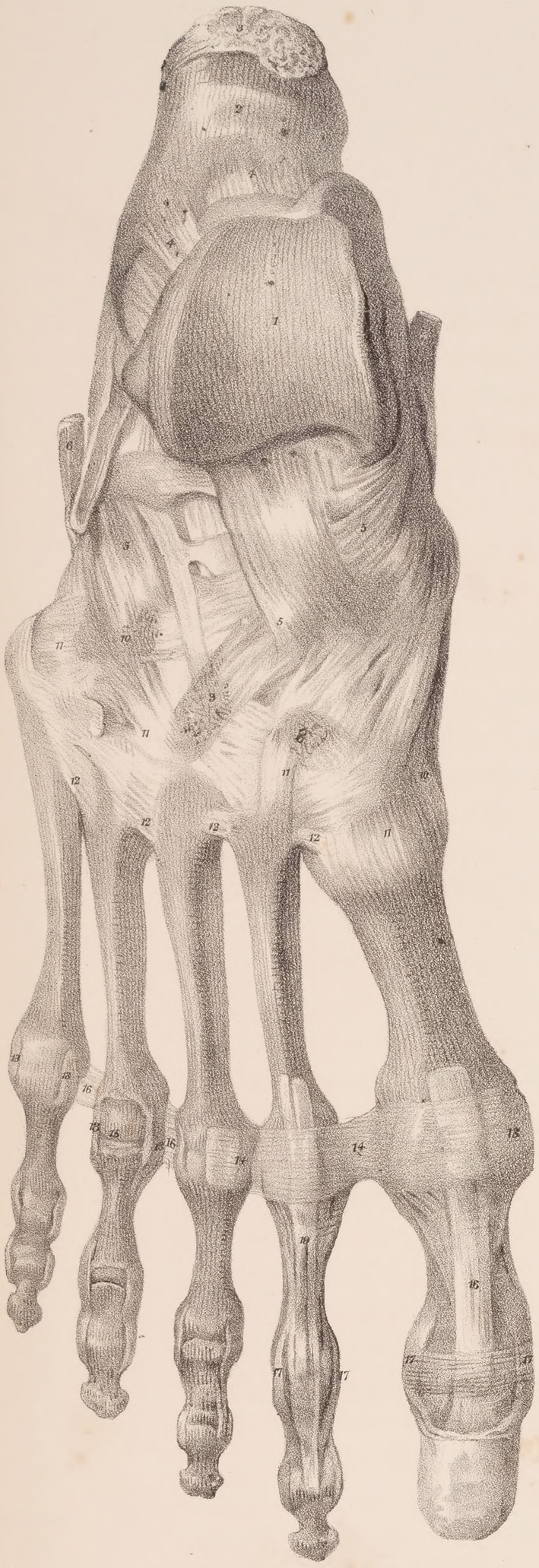

Fig 4.

Fig 3.

Fig 2.

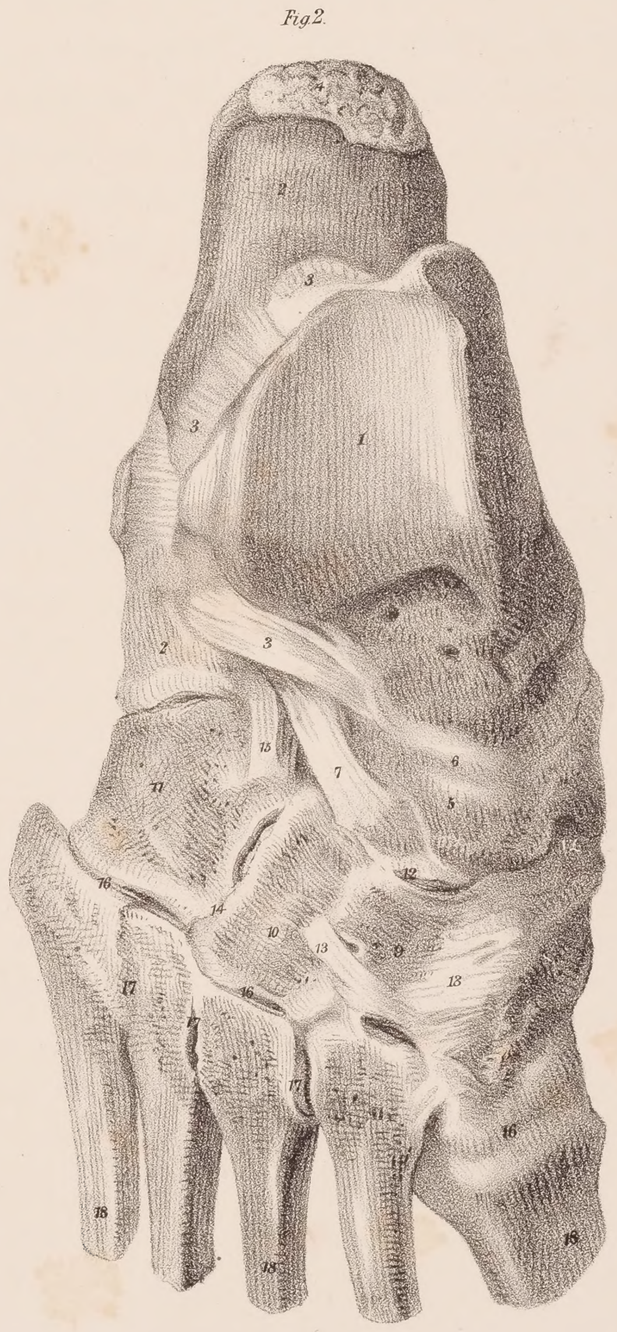

Fig 5.

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The superior border, near the margin of its notch, to the omo-hyoideus: the coracoid process, anteriorly, to the pectoralis minor; by its summit, to the biceps and coraco-brachialis. The posterior border or base, anteriorly, to the serratus magnus; posteriorly, to the supra-spinatus and infra-spinatus; in the inter-space, to the rhomboidei and to the levator anguli scapulæ. The inferior or axillary border, at its upper part, by a rough ridge, to the long portion of the triceps extensor; posteriorly, by an unequal surface, to some fibres of the teres minor; inferiorly, to the teres major.

The inferior angle, to the teres major, and occasionally to some fibres of the latissimus dorsi; the anterior angle, (glenoid cavity,) by its upper margin, to the long head of the biceps muscle.

Developement.—When the scapula is examined at a very early period, it appears as a thin lamella without any elevation corresponding with the spine. Soon after, an osseous centre is seen towards the middle of its dorsum, one in the coracoid process, and in the acromion. The base and the inferior angle also commence by separate points.

The Clavicle.—The clavicle (*clavis*, a key), plate XVI. figs. 1, 2; plate XVII. figs. 4, 5, or, as it is popularly called, the collar-bone, is extended, transversely, between the acromion process of the scapula and the summit of the sternum, which it serves to connect; its direction, however, is not exactly horizontal, the acromial end being slightly elevated. This bone is curved somewhat like an italic *f*, the degree of the curvature being less in young and female subjects than in male adults; it is rather thick and somewhat triangular towards its sternal end, but broad and flat towards the scapular extremity; it presents for our consideration a body and two extremities. The superior surface of the body is principally subcutaneous. The inferior surface presents, near the sternal extremity, inequalities for the attachment of the costo-clavicular ligament; in the centre, a longitudinal depression, giving attachment to the subclavius muscle, the foramen for the entrance of the medullary vessels, and, more externally, a rough oblique line, to which the coraco-clavicular ligaments are attached; this surface corresponds internally to the first rib, externally to the coracoid process and the shoulder-joint, and in the middle to the axillary vessels and brachial plexus of nerves. The anterior border is broad and convex towards the sternal, thin and concave towards the scapular extremity; the posterior border presents, of course, the opposite arrangement of curvatures. The internal extremity is inclined downwards and forwards; it is considerably thicker than the other parts of the bone, and terminates in a triangular unequal surface, which is convex from above downwards, concave from behind forwards; this is tipped with cartilage, and articulates with the sternum, the articular surface of which it much exceeds in size; its entire circumference gives attachment to ligaments. The external or scapular extremity, compressed and flattened, inclines a little backwards and upwards, and articulates with the acromion by a narrow oblong surface which is covered with cartilage.

Attachments of muscles.—The clavicle gives attachment, by the superior surface of its sternal extremity, to the sterno-cleido-mastoid; the longitudinal depression on its inferior surface, to the subclavius; the anterior border, by its sternal half, to the pectoralis major; by its acromial third, to the deltoid; the posterior border, by its acromial third, to the trapezius.

Articulations.—The clavicle articulates with the sternum and the acromion process of the scapula.

Developement.—The division of the bone above indicated into body and extremities is merely technical, being intended to facilitate its description. It consists of one piece, and grows from one ossific centre.

The Humerus.—The humerus or arm-bone, plate XVII. figs. 1, 2, 3; plate XVIII., (os humeri,) the largest bone of the upper extremity, extends from the scapula to the bones of the fore-arm, with each of which it is articulated. Its direction is vertical, with an inclination inwards towards the lower end. Long and irregularly cylindrical in form, the humerus is divisible into a body and two extremities.

The *body* or shaft of the bone, thick and rounded superiorly, is somewhat expanded, and triangular inferiorly. It is divided into two nearly equal surfaces by two longitudinal lines, of which one is external and anterior, the other internal and posterior. These lines may be considered as rising, the former from the external, the latter from the internal condyle, near to which they are well marked, but gradually subside as they proceed upwards on the body of the bone: they afford attachment to the inter-muscular aponeuroses. The external one is interrupted about the middle by an oblique depression, or groove, which runs from above downwards, and marks the course of the musculo-spiral nerve and superior profunda artery; the surfaces separated by these lines are named posterior and anterior. The *posterior* surface is round superiorly, and inclined a little inwards; in the lower part it is broad, flat, and turned rather outwards; it is covered in the entire

of its extent by the triceps extensor muscle, and towards its middle may be observed a small foramen for the medullary vessels. The *anterior* surface is divided superiorly into two unequal portions by a longitudinal groove, directed obliquely downwards and inwards, for about one-fourth of the length of the bone; this lodges the long tendon of the biceps muscle, and is therefore named the *bicipital* groove; its anterior margin gives attachment to the pectoralis major; the posterior, to the latissimus dorsi and teres major. The portion of the anterior surface which is internal to this groove is smooth in the greater part of its extent, and presents, towards its middle, a linear elevation for the insertion of the coraco-brachialis, and lower down an oblique medullary foramen; externally to the groove, and a little above the middle of the bone, may be observed a broad rough eminence, for the insertion of the deltoid muscle, beneath which runs the oblique depression already noticed as corresponding to the course of the musculo-spiral nerve and the accompanying artery.

The *superior extremity* of the bone presents a large hemispherical eminence, covered with cartilage in the fresh state, and directed backwards and inwards to the glenoid cavity of the scapula, with which it articulates; this is called the *head* of the humerus. It is bounded by a slightly depressed groove, sufficiently marked on the upper, not on the under aspect, denominated the *neck* of the bone. A little beneath, and to the outside of the head, are two eminences, which project from the ends of the shaft of the bone, and, from their relative size, are named the greater and lesser *tuberosities* (tubercula). The greater tuberosity is external and posterior in its situation, convex in its outline, and marked on its upper border by three flat surfaces for the insertion of the external rotator muscles. The smaller tuberosity, rounded and more prominent than the other, gives attachment to the sub-scapularis muscle. They are separated by the bicipital groove. Towards its lower third the bone widens, and appears compressed and somewhat twisted from behind forward; its greatest diameter is transverse; it presents internally a considerable projection, the *inner condyle*, which is inclined backwards, and gives attachment to the internal lateral ligament of the elbow-joint, and to a tendon common to the greater number of the anterior muscles of the foramen. Externally is situated another smaller process, (*external condyle*,) to which are attached the external lateral ligament and a tendon common to the muscles of the posterior and external surfaces of the fore-arm. Between the condyles is placed the inferior articular surface, which is inclined somewhat forwards. Proceeding in the enumeration of the parts which enter into its composition from the radial to the ulnar side, we observe a rounded eminence placed rather on the anterior surface of the bone, and articulating with a cavity observable on the superior extremity of the radius, calculated to allow of all that freedom of motion which the radius enjoys, viz. flexion and extension on the humerus, and pronation and supination by rotation on its own axis;—a slight groove or depression corresponding with the circumference of this eminence, a semicircular ridge, which is lodged in the space intervening between the radius and ulna;—a wide and deep groove, which receives the prominent part of the larger sigmoid cavity of the ulna; and, lastly, a prominent ridge, which is received into the internal part of the same cavity. This prominence descends much lower than the external portion of the articular surface, and determines an obliquity in the direction of the humerus, when its lower extremity is made to rest on a plain surface. The groove, with its margins, forms a well-marked pulley-like surface, on which the sigmoid cavity of the ulna moves in flexion and extension; hence it is termed the *trochlea.* At the fore part of the inferior extremity of the bone, and immediately above the trochlea, is a superficial depression, which receives the coronoid process of the ulna during flexion; and posteriorly a more considerable fossa, which lodges the olecranon during the extension of the fore-arm.

A modification of the nomenclature applied to these different eminences has been proposed by Chaussier: retaining the term trochlea for the surface of articulation with the ulna, he calls that which articulates with the radius, the condyle; (it is sometimes called the *small head;*) and for the two lateral eminences of insertion, now named condyles, he substitutes the terms *epi-trochlea* and *epi-condyle.*

Attachments of muscles.—The posterior surface gives attachment to the triceps; the anterior (by the posterior margin of the bicipital groove), to the teres major and latissimus dorsi; in the middle, by a slightly-marked line, to the coraco-brachialis; inferiorly, to the brachialis anticus;—the external portion of the same surface, superiorly, by a rough eminence, to the deltoid; by the anterior margin of the bicipital groove, to the pectoralis major. The greater tuberosity gives attachment, by the three flat surfaces on its upper border, to the supra-spinatus, infra-spinatus, and teres minor muscles; the lesser tuberosity, to the sub-scapularis. The inferior extremity, by its outer border, to the supinator radii longus, and, by its external condyle, to the extensor

carpi radialis longior and brevior, extensor communis digitorum, extensor carpi ulnaris, anconeus and supinator radii brevis; by the internal condyle, to a tendon common to the pronator radii teres, flexor carpi radialis, palmaris longus, flexor carpi ulnaris, and flexor digitorum sublimis.

Articulations.—The humerus articulates with the glenoid cavity of the scapula, and with the ulna and radius.

Developement.—The shaft of the bone grows from one ossific centre; the head and the two tuberosities have each their own points. So have the two condyles and the trochlea.

The Radius.—The radius, plate XVII. figs. 1, 2, 3; plate XIX. fig. 1, shorter than the ulna by the length of the olecranon process, is placed at the external side of the fore-arm, extending from the humerus to the carpus. It is broader below than above, slightly curved in its form, and divided into a body and two extremities. As the body is somewhat triangular, we observe on it three surfaces, bounded by three margins or ridges. The *anterior* surface expands towards the lower part, and is marked along its middle by a longitudinal groove for the flexor pollicis longus; superiorly is situated the foramen for the medullary vessels, its direction being from below upwards; and inferiorly a flat surface, corresponding with the pronator quadratus. The *posterior* surface, convex in the greater part of its extent, is grooved at its central third, for the origin of the extensors of the thumb; the *external* surface, round and convex, is marked towards its middle by a rough impression, which gives insertion to the pronator radii teres. Of the margins separating these surfaces, the posterior is distinct only at the middle part; the external is round, and becomes smooth towards the lower extremity; whilst the internal is acute and sharp, for the attachment of the interosseous ligament. The body is terminated superiorly by a rough prominence, (tuber radii,) termed the *bicipital tuberosity*, from its giving insertion to the biceps muscle.

Above the tuberosity the bone becomes narrowed and constricted into the form of a *neck*, which is again surmounted by the *head*, intended by its extremity to articulate with the round convex part of the lower extremity of the humerus, its small head (condyle, Chauss.), while its margin rolls on the lesser sigmoid cavity of the ulna. The margin is smooth and convex; the upper surface, also smooth, is a shallow cup-like cavity; and both are covered with cartilage in the recent state.

The radius at its lower part becomes broad and thick; the anterior surface is flat and expanded, being covered by the pronator quadratus muscle; it is bounded below by a prominent line, which gives attachment to the anterior ligament of the wrist-joint. The posterior surface is convex, and marked by grooves which transmit the tendons of the extensor muscles; of these, one, which is very narrow and oblique in its direction, and nearly in the middle line, lodges the tendon of the extensor pollicis (secundi internodii). At the inner or ulnar side of this is placed another, much broader, which transmits the tendons of the extensor communis and indicator; and at its outer side, a third, divided into two parts by a linear impression, marks the passage of the flexor carpi radialis, longior and brevior. Corresponding with the external border of the bone is another groove, directed obliquely forwards, and divided into two parts, for the tendons of the extensores—primi internodii, and ossis metacarpi pollicis. The outer side of the bone, particularly the part corresponding with the ridge which separates the two latter grooves, is prolonged downwards, and named the *styloid process;* it affords attachment to the external lateral ligament of the wrist-joint. On the inner side of the bone is situated a small cavity, (semilunar,) covered by cartilage, which articulates with the inferior extremity of the ulna. At its inferior extremity the radius presents its carpal articulating surface, (scaphoid; navicular,) which is included between the base of the styloid process and the oval cavity just mentioned, bounded before and behind by two rough margins for the attachment of the radio-carpal ligaments. It is divided from before backwards, by a line, into two unequal portions, of which the external is triangular, and articulates with the scaphoid bone; the internal is square, and articulates with the semilunar.

Attachments of muscles.—The anterior surface of the body, by its grooved part, to the flexor longus pollicis; by the oblique line, leading from the tuberosity to the insertion of the pronator radii teres, to the supinator brevis and flexor sublimis; its inferior fifth, to the pronator quadratus; the posterior surface, by a slight concavity in the middle, to the extensores pollicis; the external margin, by a rough surface, to the pronator teres; inferiorly, to the pronator quadratus and the supinator radii longus; whilst the posterior part of the bicipital tuberosity gives attachment to the biceps muscle.

Articulations.—The radius articulates with the humerus, the ulna, the scaphoid and semilunar bones.

Developement. — It has a centre of ossification for its body, and one for each extremity.

The Ulna.—The ulna, plate XVII. figs. 1, 2, 3; plate XIX., (ωλενη, cubitus,) is placed at the inner side of the fore-arm; it is a long and rather irregular bone, larger at the upper than at the lower extremity,—a conformation the reverse of that which obtains in the radius. Its body, or shaft, is marked off into three surfaces by three prominent lines. These are all broader above than below, in consequence of the decreasing size of the bone. The anterior surface, slightly depressed, is grooved longitudinally for the origin of the flexor profundus, and marked at its upper third by a foramen, directed obliquely upwards for the medullary vessels. The internal surface, smooth and somewhat excavated superiorly, is covered in the greater part of its extent by the flexor profundus muscle; it becomes round inferiorly, where it is subcutaneous. The external surface, rough and irregular, is divided into two parts, of which one, of small extent, corresponds with the superior extremity of the bone, and forms an elongated depression for the anconeus muscle; the other, reaching to the lower extremity, gives origin to the extensors of the thumb and the supinator radii brevis. Of the three margins, the internal and posterior are round, and for the most part smooth; the external is sharp, and gives attachment to the interosseous ligament.

At the superior extremity of the bone are situated two eminences, so placed as to bound the cavity by which it articulates with the humerus. Of these, one, called *olecranon*, (ωλενη, ulna; κρανιον, the head,) is nearly on a line with the shaft of the bone; the other, the *coronoid process*, (κορωνη, a crow's beak; ειδος, like,) projects from its anterior surface. The olecranon terminates in a rough tuberosity and an obtuse point; the former giving insertion to the triceps extensor; the latter being lodged, when the arm is extended, in the posterior cavity at the end of the humerus. Anteriorly, this process is smooth and hollowed out, to form part of the surface of articulation with the humerus; posteriorly, it presents a flat triangular surface, which is subcutaneous. The coronoid process, by a gentle ascent, rises upwards and forwards from the anterior surface of the bone, and terminates in a sharp ridge, which overhangs the articular surface, and is received during flexion into the anterior depression in the humerus; its anterior surface, rough and triangular, gives insertion to the brachialis anticus muscle; its upper aspect is smooth and excavated; its inner border gives attachment to the internal lateral ligament; the external is hollowed into a smooth depression, the *smaller sigmoid cavity*, which articulates with the head of the radius. The *great sigmoid cavity*, formed by the junction of the smooth surfaces of these two processes, has been so named from some supposed resemblance to the form of the Greek letter Σ (σιγμα, ειδος, like), as it was originally written. Covered by cartilage in its entire extent, it is divided into two parts (but unequally, the inner one being the larger,) by a smooth ridge running downwards from the peak or point of the olecranon to that of the coronoid process. This ridge and the concavities beside it correspond, the one with the groove, the others with the lateral parts of the trochlea. At the margins of the sigmoid cavity may be observed two notches, which mark off the parts of the surface which belong to the olecranon and the coronoid process respectively.

At the inferior extremity of the bone, which is small and rounded, are situated two eminences, of which the external one, named the *head* of the ulna, round and covered with cartilage, presents two aspects, of which one, nearly circular in its form, looks towards the wrist-joint, and corresponds with the triangular fibro-cartilage of that articulation; whilst the external one, narrow and convex, is received into the semilunar cavity in the contiguous border of the radius. The internal eminence, named the *styloid process*, projects on a line with the posterior and inner surface of the bone; it is elongated in its form, and gives attachment to the internal lateral ligament of the joint. The head and the styloid process are separated posteriorly by a groove, which is traversed by the tendon of the extensor carpi ulnaris, and inferiorly by a depression at the base of the styloid process into which the triangular fibro-cartilage is inserted.

Attachments of muscles.—The anterior surface, superiorly and in the middle, gives attachment to the flexor digitorum profundus; inferiorly, to the pronator quadratus; the posterior surface, to the anconeus, the extensor carpi ulnaris, supinator radii brevis, the extensores pollicis, and the extensor indicis; by the posterior longitudinal line, to an aponeurosis common to the flexor carpi ulnaris, flexor digitorum profundus, and extensor carpi ulnaris. The superior extremity, by the summit of the olecranon, to the triceps brachialis; the coronoid process, by its anterior rough surface, to the brachialis anticus; and by its internal side, to the second origin of the pronator teres.

Articulations. — The ulna articulates with the humerus and the radius; it has no point of

contact with the carpal bones, but it is brought into relation with the cuneiform bone by means of the inter-articular fibro-cartilage.

Developement.—The shaft of the ulna, as in other long bones, has its own osseous centre; so has the lower extremity or head, as well as the olecranon process.

Hand.—The hand [plate XX.] is composed of the carpus, metacarpus, and fingers.

Carpus.—The first or superior part of the hand is named the carpus or wrist; it is placed between the fore-arm and the metacarpus, and composed of eight small bones, which are disposed in two ranges, each consisting of an equal number. Proceeding in the enumeration from the radial to the ulnar side, the bones which constitute the first or superior range are thus named from their shape—scaphoid, semilunar, cuneiform, and pisiform; those of the second or inferior range are the trapezium, trapezoid, os magnum, and unciform. The dorsal surface of the carpus is convex, the palmar concave and irregular, and marked by four bony prominences, across which is stretched the anterior annular ligament, so as to form a canal for the transmission of the flexor tendons.

Bones of the first row.—The Scaphoid bone.—The scaphoid or boat-shaped bone [plate XX.] (σκαφη, a boat) is the first of this row, and the largest. Its position is oblique, so that its broad end is directed towards the trapezium and root of the thumb, whilst the narrow one inclines inwards and upwards to the middle of the articular surface of the radius. It is convex on one side, concave on the other. The concave or hollowed surface (scaphoid) looks obliquely inwards and forwards, and is that which determines the form and gives name to the bone. Its upper articular surface, convex and triangular, is applied to the radius; the lower, also convex, articulates with the trapezium and the trapezoid bone. Its concavity receives part of the head of the os magnum; close to this is a narrow articular surface which is in contact with the semilunar bone; on its radial side is a rough surface, to which is attached the external lateral ligament of the wrist-joint; posteriorly is a narrow grooved surface for the attachment of ligaments; and anteriorly is a rough surface, the inner or ulnar half of which is narrow and slightly grooved, whilst the outer is prominent and tuberculated for the attachment of ligaments. It articulates with five bones.

The Semilunar bone.—The name of this bone [plate XX.] is taken from its being concave or crescentic on its inferior surface. Irregularly triangular in its form, convex superiorly, it articulates with the square part of the articular surface of the radius; inferiorly concave, with the os magnum and the unciform; on the ulnar side, with the cuneiform; on the radial side, with the scaphoid; anteriorly and posteriorly it gives attachment to ligaments. It articulates with five bones.

The Cuneiform bone.—This is the "wedge-shaped" bone [plate XX.]; sometimes also it is named from its form "pyramidal:" superiorly it is in relation with the inter-articular fibro-cartilage of the wrist-joint; inferiorly it articulates with the unciform bone; on the ulnar side, gives attachment to ligaments; on the radial side, articulates with the semilunar bone; anteriorly it affords attachment to ligaments, and presents a small articular surface for the pisiform bone. It articulates with three bones.

The Pisiform bone.—The "pea-shaped" bone [plate XX.] is placed on a plane, anterior to the other bones of the carpus. Its form is indicated by its name (*pisum*, a pea). It presents but one articular surface, which is situated on the posterior part, or base, and rests on the anterior surface of the cuneiform bone; it affords attachment to the annular ligament of the carpus, to the flexor carpi ulnaris muscle, and to the abductor of the little finger.

The first three carpal bones form, when in apposition, a rounded convex surface, which corresponds with the concavity presented by the radius and the inter-articular cartilage; but their lower surface constitutes a deep hollow, which receives the head of the os magnum and the unciform bone.

Bones of the second row.—The Trapezium.—The name of this bone [plate XX.] is taken from its presenting four unequal edges at its posterior aspect. It is placed at the radial border of the carpus, between the metacarpal bone of the thumb and the scaphoid bone. It is known by the angular appearance of its dorsal surface, and by the tubercle and groove at its palmar aspect. Superiorly concave, it articulates with the scaphoid bone; inferiorly concave from behind forward, and convex transversely, with the first metacarpal bone; on the ulnar side, with the trapezoid bone, and, by a small surface situated more inferiorly, with the edge of the second metacarpal bone; on the radial and posterior sides it gives attachment to ligaments; anteriorly it presents a groove traversed by the tendon of the flexor carpi radialis, and a tubercle to which the annular ligament of the carpus is attached. It articulates with four bones.

The Trapezoid bone.— This is a small bone [plate XX.], compared with those between which it is placed, viz. the trapezium, scaphoid, and os magnum ; in form and position it has some resemblance to a wedge, and but little to a trapezium, except that its posterior surface is bounded by four unequal edges. It articulates superiorly with the scaphoid bone ; inferiorly, with the second metacarpal bone ; on the ulnar side, with the os magnum ; on the radial side, with the trapezium : the anterior and posterior surfaces afford attachment to ligaments. It articulates with four bones.

Os magnum.—This [plate XX.] is the largest of the carpal bones ; its form is oblong, round superiorly, cubic inferiorly ; the superior surface, named its "head," (whence it is sometimes called os capitatum,) is supported by a narrowed portion, named the "neck ;" its greatest convexity is in the antero-posterior direction, where it is received into a cavity formed by the scaphoid and the semilunar bone ; it articulates, inferiorly, by three distinct surfaces, of which the middle is the largest, with the second, third, and fourth metacarpal bones ; on the ulnar side, with the unciform bone ; on the radial side, with the trapezoid bone : the anterior and posterior aspects are rough (particularly the former) for the attachment to ligaments. It articulates with seven bones.

The Unciform bone.— The "hooked-shaped" bone [plate XX.] (*uncus*, a hook) is readily distinguished from the rest by the curved process upon its palmar surface : it articulates, superiorly, with the semilunar bone ; inferiorly, by two distinct surfaces, with the fourth and fifth metacarpal bones ; on the ulnar side, with the cuneiform bone ; on the radial side, with the os magnum : anteriorly its hooked process affords attachment to the anterior annular ligament of the carpus ; posteriorly a rough surface also gives attachment to ligaments. It articulates with five bones.

The Metacarpus.—This [plate XX.] forms the second or middle portion of the hand, being situated between the carpus and the phalanges ; it is composed of five bones, which are named first, second, &c., in their numerical order, the enumeration being commenced at the radial side. These bones are placed parallel one with the other, and nearly on the same plane, with the exception of the first, which is more anterior than the rest, and alters its relative position to them in its various movements. They vary in size, the first being thicker and shorter than the others ; and these gradually diminish in length from the second to the fifth. They are all slightly concave on the palmar surface, convex on the dorsal, larger at their extremities than in the bodies or middle part, terminated at the carpal extremity by an unequal eminence, and at the digital by a rounded head.

The bodies are lengthened and somewhat compressed, but may, in each, be regarded as presenting a palmar, a dorsal, and two lateral surfaces. The palmar surface is narrow, and presents in the middle a prominent line, which separates the attachments of the inter-osseous muscles, and corresponds with the tendons of the flexor muscles ; as also, in the first, to the opponens and flexor brevis pollicis, and in the third to the origin of the adductor pollicis.

The dorsal surface, convex and smooth in the first, presents in the second, third, and fourth a longitudinal line, which, bifurcating, forms the sides of a triangular surface, extending over two-thirds of their length ; in the fifth, also, is observed a prominent longitudinal line, directed obliquely from the ulnar to the radial side. The lateral surfaces afford attachment to the dorsal inter-osseous muscles ; broad in the four last bones, these surfaces are narrowed, and form merely borders in the first.

The carpal extremity presents, in each, some peculiarities which render a separate description necessary : on the first is observed a surface, which is concave in the antero-posterior and convex in the opposite direction, which articulates with the trapezium ;—in the second, a concave surface articulates with the trapezoid bone, and on the radial side, a small surface, with the trapezium ; at the ulnar side, its margin is extended obliquely backwards, so as to become wedged in between the trapezium and the third metacarpal bone, and articulates by its tip with the os magnum ;—on the third, a nearly plain surface articulates with the os magnum ; on the radial and ulnar sides are surfaces for articulation with the contiguous metacarpal bones ; on the fourth two articular surfaces move upon the os magnum and unciform, on the radial side there are two surfaces, and on the ulnar side one, for articulation with the corresponding surfaces of the bones on each side ;—on the fifth, a concave surface, directed outwards, corresponding with the unciform bone ; and, on the radial side, a surface for the fourth metacarpal bone.

The anterior or digital extremities of all are convex, and articulated with the phalanges, the smooth surfaces extending farther on the palmar than on the dorsal aspect of the bones ; and on the margins of these are inequalities for the attachment of ligaments.

Bones of the Fingers.— These [plate XX.] are fourteen in number ; each, with the exception of

the thumb, having three separate pieces (*phalanges, internodia*). Of these the first is longer than the second, and the second than the third. Like other long bones, each is divided into a body and two extremities, of which one represents the base and the other the head. Winslow and some other anatomists reckon three phalanges in the thumb, as they conceive that its posterior or most moveable bone resembles the first phalanges of the fingers, rather than the metacarpal bones. But if its conformation be examined with attention, more especially that of its anterior extremity, and also its mode of articulation with the bone in front of it, its analogy with the metacarpal range will appear more striking than with the first digital phalanges; and so it is considered by Meckel, Portal, H. and J. Cloquet. The bodies of the first row or phalanx are convex on the dorsal surface, and flat from side to side on the palmar, but arched from before backwards; the palmar surface is bounded by two margins which give insertion to the fibrous sheaths of the flexor tendons. The larger or posterior extremities present an oval smooth surface, whose greatest diameter is from side to side, intended to receive the convex heads of the corresponding metacarpal bones. The anterior extremities, smaller than the other, end in two small lateral condyles, with a slight groove between them, both being adapted to the base of the contiguous bones, so as to form ginglymoid or hinge-joints. The articular surface is prolonged farther on the palmar than on the dorsal aspect, which allows a more free range to the motion of flexion. The margins of the articular surfaces are rough and prominent for the attachment of ligaments.

The second row consists of four bones, the thumb having only two pieces corresponding with those of the first and last phalanx. Smaller than the preceding set, they still resemble them in their general outline. The broader or posterior extremity ends in an articular surface, divided by a slight ridge extending from before backwards, the lateral parts being concave for the reception of the two eminences on the contiguous bone; the anterior extremity is divided into two lateral convex surfaces, which are lodged in depressions in the base of the last phalanx.

The third row (*phalanges unguium*, Sœmm.) consists of five pieces, that of the thumb being the largest. They are convex on the dorsal, flat on the palmar surface; rough at the summit, which corresponds with the points of the fingers, and at the base, for the attachment of ligaments and the flexor tendons. The articular surface, at the base, resembles that of the base of the second phalanx in having two shallow concavities divided by a central convex line.

Attachments of muscles.—1. To the carpal bones. The *pisiform* bone gives origin to the abductor minimi digiti, and insertion to the flexor carpi ulnaris; the *trapezium*, to the opponens and abductor pollicis; the *trapezoid*, to part of the flexor brevis pollicis; the *os magnum*, to part of the same; the *unciform*, to the flexor brevis (minimi digiti) and to the adductor.

2. To the metacarpal bones. The *first*, or that of the thumb, gives insertion to the extensor ossis metacarpi pollicis and to the opponens pollicis, and origin to part of the abductor indicis: the *second*, or that of the forefinger, to the flexor carpi radialis at its palmar end, and to the extensor carpi radialis longior on the dorsal surface of its base, and, by its lateral surfaces, to the two first dorsal inter-ossei muscles and one palmar: the *third*, to the extensor carpi radialis brevior, to the adductor pollicis, and also to two dorsal inter-ossei: the *fourth*, to two dorsal inter-ossei and one palmar: the *fifth*, to the extensor carpi ulnaris, and the adductor or opponens minimi digiti, to one dorsal and one palmar inter-osseous muscle.

3. To the bones of the fingers. Those of the *first* range of the four fingers give attachment by their lateral borders to the tendinous sheaths of the flexor tendons; their dorsal surface is covered by the expansion of the extensor tendons. The bones of the *second* row give insertion at their dorsal surface to the tendons of the extensor communis; the tendons of the flexor sublimis are inserted into their bases at the palmar surface. The *third* set gives insertion to the tendons of the flexor profundus; the fibres of the extensor communis are also continued on their dorsal aspect.

The *first* phalanx of the thumb gives insertion to the extensor primi internodii, to the flexor brevis, to the adductor and abductor pollicis: the *second* phalanx to the flexor longus, and to the extensor secundi internodii.

Of the Pelvis.—The pelvis, or "basin-shaped" cavity [plate XV.] is placed at the lower extremity of the trunk, being formed by the union of the ossa innominata, the sacrum, and the coccyx. Its form is somewhat circular; its size presents many varieties, dependent on the sex and age of the subject, as well as on individual conformation. In young subjects the two large lateral bones, the ossa innominata, are divided each into three pieces, the ilium, ischium, and os pubis; the sacrum consists of five pieces, resembling in some respects the bones of the vertebral column, and hence

called false vertebræ; these in adult age become united into one. The coccyx, or caudal prolongation, consists of four pieces.

The Sacrum.—The sacrum [plates IV. VI. XIV. XV.], when the body is in the erect position, is placed at the superior and posterior part of the pelvis, beneath the last lumbar vertebra, above the coccyx, and between the ossa innominata, between which it is inserted in some measure like a keystone into an arch.

Its figure is triangular in its general outline; concave anteriorly, convex posteriorly. We consider successively its surfaces, borders, and extremities.

The anterior or pelvic surface is nearly flat from side to side, concave from above downwards, and marked by four transverse lines, indicating its original division into five pieces; laterally it presents four foramina, (anterior sacral,) for the transmission of the anterior branches of the sacral nerves. These are directed outwards, and diminish gradually in size from above downwards; external to these the surface gives attachment to the pyramidalis muscle.

The posterior or spinal surface is convex and presents along the median line four small eminences, usually connected so as to form a ridge; these are rudiments of the spinous processes; and beneath them is a triangular groove, or rather an opening, marking the termination of the sacral canal. The margins of the opening present two tubercles, which give attachment to the ligament that closes in the canal. The inferior pair (sacral cornua) articulate with the horns of the coccyx. At each side of the median line are two grooves, pierced by the posterior sacral foramina, which are much smaller than the anterior, and transmit the posterior branches of the sacral nerves.

The borders, or lateral surfaces of the sacrum, present two distinct parts, one superior, (iliac,) large and irregular, which in the fresh state is covered with cartilage, and articulated with the ilium; the other inferior, thin and narrowing to a point, gives attachment to the sacro-sciatic ligaments. A small indentation terminates this border, which, with the corresponding extremity of the coccyx, forms a notch for the transmission of the fifth sacral nerve.

The *base*, or superior extremity, broad and expanded, presents, 1st, towards the middle line, an oval surface, cut off obliquely, and tipped with cartilage for its articulation with the last lumbar vertebra; behind this is a triangular aperture marking the orifice of the sacral canal. 2nd, On each side a smooth convex surface, inclined forwards, and continuous with the iliac fossa; an articular process, concave from side to side, which looks backwards and inwards, and receives the inferior articular process of the last lumbar vertebra. Before each articular process is a groove, forming part of the last inter-vertebral foramen, and behind them is a curved, sharp, and depressed border, which bounds the sacral canal, and therefore corresponds with the lateral arches of the vertebræ, and gives attachment to the last ligamentum subflavum.

The *apex*, or inferior extremity, directed downwards and forwards, presents an oval convex surface, which articulates with the coccyx.

The sacrum in its interior contains much loose spongy substance, and its exterior layer is but moderately compact. Its central part is also hollowed into a canal (sacral), which curves from above downwards as the bone does; hence it is of a triangular form, and gradually narrows as it descends.

Attachments of muscles.—The sacrum gives attachment, by the lateral parts of its anterior surface, to the pyramidales muscles; by its posterior surface at each side, to the gluteus maximus, sacro-lumbalis, longissimus dorsi, and multifidus spinæ; by the inferior part of each border, to part of the coccygeus.

Articulations.—The sacrum articulates with the last lumbar vertebra, the two iliac bones, and the coccyx.

Developement.—In the first three pieces there are found five bony points, one being in the body, two at the sides in front, and two posteriorly in the arches. Analogy would lead us to admit two more in each body corresponding with its upper and lower surfaces, and one in the spinous process, in all eight. In the two lower false vertebræ there appear to be but three, one being in the body and one at each side.

Ossa Coccygis.—These bones [plates IV. VI. XIV.], when united together, which is usually the case in advanced life, are supposed to resemble a cuckoo's bill, and are therefore called coccygeal (κοκκυξ, a cuckoo). Most commonly there are four of them, sometimes but three; in a few instances five have been found. They diminish gradually in size from above downwards, which gives them, when taken together, a pyramidal form. As they are placed in a continuous line with the inferior third of the sacrum, they form a slightly concave surface anteriorly, a convex one posteriorly.

The first of these bones resembles, in some measure, the last false vertebra of the sacrum. Its body is small and concave at its upper aspect, which articulates with the extremity of the sacrum;

posteriorly, two small processes, termed cornua, project, which rest upon the sacral cornua. The second bone of the coccyx is somewhat square, the third oblong, and the fourth a small rounded nodule of bone.

Attachments of muscles.—The coccyx gives attachment to the gluteus maximus, and to the coccygeus of each side, and by its point to the sphincter ani. Its base articulates with the sacrum.

Each of these pieces has a separate osseous centre.

Os innominatum.—This bone [plates XIV. XV. XXIII.], is of so complex and irregular a form, that it bears no perceptible resemblance to any other known object, and therefore remains "unnamed' and unnameable. The two bones thus distinguished by the negation of a name are situated at the inferior and lateral parts of the trunk, extending from the sacrum forwards to the median line, where they are connected together. Through the intervention of the sacrum, which is wedged in between them, they receive the weight of the body from the vertebral column, and transmit it to the lower extremities: thus placed, and being somewhat curved in their general outline, they circumscribe the greater part of the cavity of the pelvis, the sides and fore-part of which they form.

To facilitate the description of this very irregular bone, it is convenient to consider separately each of the parts into which it is found divided in early life, viz. the ilium, os pubis, and ischium.

The *ilium* (os ilii), or iliac portion of the os innominatum, constitutes the upper part of the bone where it is broad and expanded; it is situated at the superior and lateral part of the pelvis. Its surfaces, borders, and angles must be considered successively.

The external surface (*dorsum*), convex before, concave posteriorly, is marked by two curved lines running from before backwards; the superior one, commencing at the anterior-superior spinous process, arches downwards to the margin of the sacro-sciatic notch. A space, narrowed before, and wider posteriorly, is included between the line just noticed, the margin of the crista ilii, and the border of the rough surface for the attachment of the gluteus maximus; from this space the gluteus medius arises. The inferior curved line is shorter and less strongly marked than the superior; it commences at the anterior-inferior spinous process, and inclines backward to the sacro-sciatic notch. The space between these lines gives origin to the gluteus minimus. On its posterior and superior part is observed a rough surface, which gives attachment to the gluteus maximus muscle. The internal surface of the ilium is divided into three parts. One anterior, smooth, concave, and of considerable extent, is called the *iliac fossa;* the posterior one is rough and uneven, and serves for its articulation with the sacrum; whilst the third is smooth, much smaller than the others, and is the only part that enters into the formation of the true pelvis.

The superior border, (*crista ilii,*) extending from before backwards, is convex and arched; it forms an epiphysis in infancy, and is sometimes called the *spine* of the ilium, but more properly its crista; its anterior extremity curves inwards, the posterior outwards. This border presents an external and internal lip (*labium*), and a rough interval, to each of which muscles are attached.

The anterior border, depressed and excavated, descends from the superior border or crista towards the os pubis, with which it is continuous: its junction with the crista is marked by a prominent point, called the *anterior-superior spinous process;* and that with the pubis, by an obtuse elevation, common to the two bones, called the *ilio-pectineal* eminence. This border presents two excavations, separated by a prominent point, called the *anterior-inferior spinous process.* The interval between the latter and the ilio-pectineal eminence gives transmission to the iliacus and psoas muscles; and that between the spinous processes transmits the external cutaneous nerve, and gives origin to some fibres of the sartorius.

The posterior border also presents two notches, separated by a prominent point of bone, called the *posterior-inferior spinous process;* above which is another bony eminence, called the *posterior-superior spinous process:* of the notches, the inferior and larger one contributes to form the sacro-sciatic notch.

Of the three angles of the bone, the two superior ones correspond with the spinous processes (anterior and posterior); the inferior is represented by the constricted part of the bone. Here we observe three surfaces (when the ilium is separated from the os pubis and ischium): one external, smooth, concave, forming part of the *acetabulum,* the deep cavity which receives the head of the femur; one anterior, small and triangular, marking the junction with the os pubis; a third posterior, the junction with the ischium.

Attachments of muscles.—To the interval between the crista and the superior curved line on the dorsal surface is attached the gluteus medius; to the space between the curved lines, the gluteus minimus; to the posterior rough surface, the gluteus maximus; to the internal surface, or iliac fossa, the iliacus muscle.

To the anterior half of the external lip of its crista is attached the obliquus externus abdominis; to the posterior third of the same lip, the latissimus dorsi; to the anterior two-thirds of the interval between the lips, the obliquus internus; and to the remainder, the erector spinæ; to the anterior three-fourths of the inner lip, the transversalis abdominis; to the posterior fourth of the same lip, the quadratus lumborum.

To the external surface of the anterior-superior spinous process is attached the tensor vaginæ femoris; to the process and the notch beneath it, the sartorius; to the anterior-inferior spine, the straight tendon of the rectus femoris; and to the brim of the acetabulum, the external tendon of that same muscle.

Articulations.—This bone articulates with the sacrum, and joins by bony union with the os pubis and the ischium.

Os Pubis.—The pubic bone [plate XXIII.], forms the anterior and inner part of the os innominatum; and is usually divided into two portions, one superior and thick, called the body, the other inferior and thin, the ramus.

The *body*, horizontal in its direction, presents three surfaces, separated by three prominent lines. The superior surface, slightly depressed, is covered by the pectineus muscle; the internal is smooth, and forms part of the pelvic cavity; the external or inferior is somewhat grooved transversely, overhangs the obturator foramen, and looks downwards to the top of the thigh.

The external extremity of the bone is thick, and presents three faces; one, concave, forms part of the acetabulum; another, superior, connects it with the ilium (the junction being marked by a rounded elevation, called the *ilio-pectineal eminence*); the third, inferior, is joined with the ischium. The internal extremity, flat and compressed, is joined to the corresponding part of the opposite bone by an intervening cartilage, the junction being termed the *symphysis pubis* ($\sigma\upsilon\mu\phi\upsilon\mu$, to grow together). Leading outwards from the symphysis, whose direction is vertical, may be observed another margin, nearly an inch in length, which is placed horizontally, and named the *crista*. The angle formed by the crista and symphysis is termed the angle of the pubes; the crista is terminated externally by a projecting nodule of bone—the *tuberosity* or spine, from which runs outwards a sharp line, (*ilio-pectineal line*,) giving attachment to Gimbernat's ligament and to the pectineus muscle, and marking the margin or upper boundary of the true pelvis.

The *ramus*, or branch of the bone, inclines outwards and downwards from the body, forming an angle with it, becomes thin, and unites with the ascending ramus of the ischium. Its inner surface is smooth; the external is rough, for the attachment of muscles. One of its borders, thick and rough and somewhat everted, forms with the opposite bone an arch, called the *arch of the pubes;* the other border, sharp and thin, forms part of the margin of the obturator foramen.

Attachments of muscles.—To the crista are attached the pyramidalis and rectus abdominis; to the tuberosity and anterior surface, the obliquus externus; to the pectineal line, the pectineus and Gimbernat's ligament; to the crista, and part of the same line, the obliquus internus and transversalis.

To the external surface, at the angle, the adductor longus; to the space between this and the border of the obturator foramen, the adductor brevis; to the line of the symphysis and the ramus, the gracilis; and to the whole margin of the foramen, the obturator externus. To the inner surface, part of the obturator internus and levator ani.

Ischium.—The *ischium* [plate XXIII.], forms the posterior and lowest part of the os innominatum; it consists of two parts, a body and a ramus, united at an angle, so as to give the bone somewhat the figure of a hook. The *body*, or larger part, short, thick, and somewhat triangular in form, presents three surfaces or aspects which look in different directions; there are three borders and two extremities. On its external surface may be observed a smooth concave part, which forms more than two-fifths of the acetabulum, and is surrounded by a curved prominent line, which forms the lower border of that cavity; beneath this is a groove, directed horizontally backwards, corresponding with the tendon of the obturator externus muscle; and still lower a rough line, which bounds the tuberosity of the ischium, and gives attachment to the quadratus femoris. The internal surface of this portion of the bone is smooth, and forms part of the cavity of the pelvis. This is broad at its upper part, as it comprises the interval between the spine, or spinous process, and the margin of the obturator foramen. Below this process it becomes narrowed, constricted, and rounded off at its back, so as to form a pulley-like surface in the interval between the spine and the tuberosity where the obturator internus muscle winds round its border. The posterior surface, broad at its upper part where it comprises the space

between the spine and the margin of the acetabulum, then becomes narrowed and depressed, finally ends in a rough and rather prominent surface bounded by well-defined borders, which is the tuberosity of the ischium.

The *tuberosity*, (*tuber ischii*,) thick and rounded, forms the part on which the body is supported in the sitting position. This rough prominence presents three impressions upon it, corresponding with the points of attachment of the three long flexor muscles of the leg.

The superior extremity of the bone (if it be examined in early life, when the bone can be detached from the ilium and os pubis, or after a section has been made of the os innominatum, so as to divide it into its three parts,) presents three surfaces, of which two are flat and triangular, and mark its junction with the ilium and os pubis; the other, concave and smooth, forms part of the acetabulum. The inferior extremity of the body of the bone is identified with the tuberosity. The *ramus* of the ischium is the flat, thin part, which ascends forwards and inwards from the tuberosity, towards the ramus of the os pubis with which it is united. One margin of the ramus, thick, rough, and somewhat everted, forms part of the inferior outlet of the pelvis; the other, thin and sharp, bounds the obturator foramen; its external surface looks outwards and downwards, is rough for the attachment of muscles; the inner surface forms part of the lower circumference of the pelvis.

Attachments of muscles.—To the outer border of the tuberosity and the contiguous part of the ramus, the adductor magnus; to the inner margin of the tuberosity at its fore-part, the erector penis; to the adjacent margin of the ramus, the transversus perinæi; the internal obturator muscle to the inner surface of the bone behind the thyroid or obturator foramen.

To the posterior surface of the tuberosity, the three flexors of the leg, *scil.* the biceps, semitendinosus, and semimembranosus; to the rough line on the outer surface which bounds the tuberosity, the quadratus femoris; to the external surface of the spine, the gemellus superior; to the adjacent border of the tuberosity, the gemellus inferior; to the internal surface of the bone, the levator ani; and to the spinous process, the coccygeus.

Developement.—The three pieces which form the os innominatum commence each with a separate point of ossification, and the extension of the osseous deposit proceeds in each towards the acetabulum as a common centre, so that when completed it is found to consist of a portion of each. Besides these, the spine of the ilium and the tuberosity of the ischium are formed separately.

Acetabulum.—At the junction of the three pieces of the os innominatum is situated the cavity which articulates with the head of the femur. It is called *acetabulum*, also the *cotyloid* or cup-shaped cavity (κοτυλη, a cup; ειδος, like). Of this the ischium forms somewhat more than two-fifths, the ilium somewhat less than two-fifths, the remainder being made up by the os pubis. It is surrounded in the greater part of its extent by a margin or supercilium, which is most prominent towards the superior and external part; but at the opposite point, or towards the obturator foramen, it is deficient, leaving a notch, (*cotyloid notch*, sometimes also called *incisura acetabuli.*) The greater part of the cavity is covered with cartilage in the natural condition; but towards the notch there is a part depressed beneath the rest, and which corresponds with the passage of the round ligament, and lodges some synovial cryptæ: this has no cartilaginous coating.

When we examine the pelvis as a whole, we observe that these articulating cavities, placed in the lateral walls of the pelvis, look outwards and forwards, and that they rest, when the body is erect, upon the globular heads of the thigh-bones, which they lodge. The margin of each cavity is rough and uneven; but in the recent state it is rendered smooth, and the depth of the cavity is increased, by a fibro-cartilaginous rim, which runs round it, and increases its depth. Where the osseous margin is deficient (at the cotyloid notch), its place is supplied by a fibrous band, so stretched across as not altogether to fill it up, but rather to bridge it over, leaving a space beneath it for the entrance of vessels into the interior of the joint.

To the inner side of the acetabulum is found, in the dried bone, a large aperture, which, however, in the natural condition, is almost completely closed by a fibrous membrane. It is called *foramen obturatorium*, perhaps more properly *obturatum*, from the circumstance of its being closed by a membrane or ligament. It is also called *foramen thyroideum* (shield-shaped; θυρεος, a shield) from its shape; and not unfrequently *foramen ovale.* It is somewhat of an oval form in the male, its greatest diameter being extended obliquely downwards and outwards; in the female it is a three-sided figure with rounded angles.

General conformation of the Pelvis.—The *pelvis*, or basin-shaped cavity, which is thus made up of the ossa innominata, the sacrum, and coccyx, deserves to be attentively examined, not merely as to the details of the parts which compose it, but as to its general conformation. Taking the objects which are deserving of notice on the external surface, from before backwards, and beginning

at the median line, we observe the *symphysis* pubis, or the line of junction between the two bones of that name; its direction is vertical, its depth greater in the male than in the female; beneath it is an angular space, the *pubic* or *sub-pubic arch*, bounded by the rami of the ossa pubis and ischia at each side. On each side of the arch is the *thyroid* or *obturator* foramen above noticed, and still more laterally the *acetabulum*, above which rises the broad convex part of the ilium (dorsum ilii). Posteriorly, along the middle line, are situated the tubercles or spinous processes of the sacrum; external to these, the posterior sacral foramina, and next, a broad, unequal surface, to which the sciatic ligaments and gluteus maximus are attached; and lastly, the large deep excavation (*sacro-sciatic notch*), bounded by the margins of the sacrum and os innominatum.

The internal surface is divided into two parts by a prominent line (*linea ilio-pectinea*) leading from the tuberosities of the ossa pubis, outwards and backwards, to the prominent point of the sacrum (*promontorium*). This constitutes the margin or brim of the *true* pelvis, all the part above it being called the *false* pelvis; as in reality it belongs to the abdomen.

The superior circumference of the false pelvis is formed on each side by the crista ilii; posteriorly may be observed a deep notch, which is divided into two parts by the base of the sacrum, and anteriorly (in the interval between the anterior-superior spinous processes of the ilia) the margin of the bone subsides, so as to present a deep excavation, which in the natural condition is filled up by the soft parietes of the abdomen. Along this margin are placed the anterior-inferior spinous processes of the ilia, the ilio-pectineal eminences, the spines or tuberosities of the ossa pubis, with their cristæ and angles. The inferior circumference or outlet of the pelvis presents three bony eminences (the tuberosities of the ischia on the sides, and the coccyx behind in the middle line). These are like so many promontories, separated by deep excavations. The anterior one (*pubic arch*), triangular in its form, is bounded on each side by the rami of the ischia and ossa pubis, extending upwards and inwards, from the tuberosities of the ischia to the symphysis pubis. The two other notches (*sacro-sciatic*) are placed behind and above the tuberosities, and correspond with the interval between the sacrum and os innominatum. When examined in the dried bones, their extent is considerable; but in the natural condition they are divided into lesser spaces by the sacro-sciatic ligaments.

The size and conformation of the pelvis differ very remarkably in the two sexes. In the female the bones are thinner, more smooth on the surface, the muscular impressions being less strongly marked, and, though its perpendicular depth is less, its breadth and capacity are greater. The alæ of the iliac bones are more expanded; the upper aperture is more nearly circular, the projection of the sacrum less perceptible; and the space between the tuberosities of the ischia greater. The depth of the symphysis pubis is less in the female than in the male, whilst the breadth of the pubic arch is greater.

In the erect attitude of the body, the direction of the pelvis is oblique, its upper aperture being inclined forwards; so much so, that if a line be drawn from the upper border of the symphysis pubis, backwards to the sacrum, it rests against the middle of that bone. In consequence of this inclination, the central line, or axis of the inlet, differs very decidedly from that of the outlet; the former, if drawn from above downwards, reaches the lower third of the sacrum; the latter, if drawn from below, backwards and upwards, touches the promontory of the sacrum; both therefore decussate towards the centre of the pelvic cavity. The different dimensions of the male and female pelvis are stated as follows, by Meckel, Cloquet, and Burns: —

		Meckel.		Cloquet.	Burns.
		In the Male Pelvis.	In the Female Pelvis.	Female.	Female.
		inch. lines.	inch. lines.	inch. lines.	inch. lines.
Between the anterior-superior spinous processes of the ilia		7 8	8 6	10 0	10 0
Between the middle points of the cristæ of the ilia . .		8 3	9 4	11 1	11 1
The transverse diameter	of the inlet	4 6	5 0	5 6	5 6
The oblique . .	of the inlet	4 5	4 5	4 7	5 5
The antero-posterior .	of the inlet	4 0	4 4	4 4	4 0
The transverse diameter	of the cavity	4 0	4 8	—	—
The oblique . .	of the cavity	5 0	5 4	—	—
The antero-posterior .	of the cavity	5 0	4 8	—	—
The transverse . .	of the outlet	3 0	4 5	4 4	4 0
The antero-posterior .	of the outlet	3 3	4 4	4 4	4 0

The last may be increased to five inches in consequence of the mobility of the coccyx.

Bones of the Lower extremity.—The lower extremity is made up of three parts; the thigh, leg, and foot.

The osseous part of the first consists of one bone—the femur; that of the leg, of two—the tibia and fibula. The adjacent extremities of these, together with the patella (a sort of sesamoid bone), form the knee.

The foot is composed of three parts, the tarsus, metatarsus, and phalanges.

The Femur.—The femur or thigh-bone, (plate XXIV., *os femoris,*) the longest bone of the skeleton, is situated between the pelvis and the tibia. In the erect position of the body, its general direction is not vertical; it gradually inclines inwards towards the lower part, so that the bones of opposite sides, though separated at a considerable distance where they are connected with the pelvis, approach each other inferiorly, and come nearly in contact. The degree of this inclination varies in different persons, and is more marked in the female than the male. The femur presents a central part, or body, and two extremities.

The *body*, or shaft, as it is sometimes called, compressed, but nearly cylindrical towards the centre, and at the same time slightly convex or arched forwards, is expanded superiorly and inferiorly. Its anterior surface, convex and smooth, is broader towards the lower than the upper extremity. Both its lateral surfaces are compressed and somewhat flat; but it may be observed that the external is somewhat concave; it affords attachment to the vastus externus muscle. The surface, which superiorly looks inwards, is, in the lower third of the bone, inclined somewhat backwards, and gives attachment to the vastus internus. The anterior surface is separated, though not in a very marked degree, from the lateral surfaces by two lines, which may be traced upwards from the condyles towards the superior extremity of the bone; but posteriorly, at the union of the two lateral surfaces, is a rough and prominent line (*linea aspera*), which gives attachment to several muscles.

The *Linea aspera* is most prominent towards the centre of the bone, and, when examined with attention, presents two margins and a rough interstice, each giving attachment to muscles. Above and below the centre, it subsides as it were towards the extremities, and also becomes bifurcated. The two superior divisions or branches of the line terminate, the one (internal and somewhat shorter) at the lesser trochanter; the other, external, at the greater trochanter; in the course of the latter a rough strongly-marked impression exists, which gives insertion to the gluteus maximus. The inferior divisions spread more asunder, and terminate at the condyles, enclosing between them and the margins of these prominences, a flat triangular portion of the bone, which corresponds with the popliteal vessels. Towards the superior part of the linea aspera may be observed a foramen directed from below upwards, which transmits the medullary vessels.

At the superior extremity of the bone is placed its neck, which is directed upwards and inwards, so as to form an obtuse angle with the body or shaft; at its point of union with the latter are two eminences (*trochanter*, major and minor), one on the outer, the other on the inner side; it is from between these that the neck arises.

The *Trochanter major* is prolonged from the external surface of the body of the bone, and nearly in a line with its axis. This apophysis, quadrilateral in its form, is convex and rough on its external surface, which is marked by a line directed obliquely downwards and forwards for the attachment of the gluteus medius; the internal surface, of less extent, presents at its base a pit, (*trochanteric* or *digital fossa,*) which receives the external rotator muscles; its superior or terminal border is flat and straight, and the posterior thick and rounded. At the posterior aspect of the great trochanter may be observed an oblique and prominent line, directed downwards and inwards, and terminating in the trochanter minor.

The *Trochanter minor*, a conical rounded eminence, projects from the posterior and inner side of the bone, and gives attachment to the tendon of the psoas and iliacus muscles.

The *neck* of the femur, which is so named from its constricted appearance and supporting the head, forms an obtuse angle with the body of the bone; it is compressed from before backwards, so that its diameter in this is much less considerable than in the vertical direction, in which greater power of resistance is required for sustaining the weight of the body: its anterior surface is broad and smooth; the superior, inclined upwards, is short and somewhat concave; the inferior is the most extensive. The union of the neck with the rest of the bone is marked by the trochanters and two intervening oblique lines, (*inter-trochanteric,*) of which, the anterior one is rough and but slightly prominent; the other, situated posteriorly, forms a smooth projecting ridge, which overhangs the trochanteric fossa.

The neck is surmounted by the globular *head*, which forms a considerable segment of a sphere,

side of the leg; it is nearly equal to the tibia in length, but is much more slender. When the fibula is placed beside the tibia in its natural position, its lower extremity will be found a little farther forward than the upper one, and its shaft inclined backwards and a little inwards, so as to be convex in that direction.

The *body* of the bone, irregularly triangular in its form, presents three prominent lines bounding three surfaces; the anterior, or most prominent line, gives origin to muscles in the superior part of its extent, and bifurcates towards its lower extremity, so as to enclose a slightly concave triangular surface, which is subcutaneous; the internal one also gives attachment to muscles, and inferiorly, where it inclines forwards, to the interosseous ligament. The *internal* surface looks backwards for about a third of its extent, and somewhat forwards in the rest, and is divided, but unequally, into two parts, by a slightly-marked longitudinal line, to which the interosseous ligament is attached for about two-thirds of its length; the part of the surface behind this is grooved,—it gives attachment to the tibialis posticus muscle; the anterior portion, the smaller, to muscles placed in front of the leg. The *external* surface, concave in the greatest part of its extent, gives origin to muscles;—towards its lower extremity, this surface is inclined backwards, conforming with the peronei muscles, which are connected with the superior part of the bone, and incline in that direction to pass behind the external malleolus. The *posterior* surface, convex and smooth, affords attachment to muscles, and presents towards its middle a small foramen, directed obliquely downwards for the transmission of the medullary vessels; in the lower part it inclines inwards, and is terminated by a rough surface connected with the tibia.

The *superior* extremity of the bone, called also the head, is smaller than the inferior one; it presents on the supero-internal part a small oval and nearly flat surface, for its articulation with the corresponding part of the external tuberosity of the tibia; the remainder is unequal, and gives insertion to the biceps flexor cruris, to the external lateral ligament of the knee-joint, and to those which connect the tibia and fibula. The *inferior* or tarsal *extremity* forms the external malleolus, which is longer and more prominent than the internal one; in front it receives the insertion of ligaments; behind is situated a shallow groove traversed by the tendons of the peronei muscles; the outer side is convex and subcutaneous; the inner presents a small triangular surface, convex in the perpendicular, and nearly plain in the antero-posterior direction, which articulates with the astragalus, and is bounded posteriorly by a rough depression, affording attachment to the transverse ligament of the ankle-joint, whilst the apex gives origin to the external lateral ligament.

Articulations.— The fibula articulates at both extremities with the tibia, and at the inferior one with the outer border of the astragalus.

Attachments of muscles. — The internal surface, by its anterior portion, to the extensor communis digitorum, extensor proprius pollicis, and peroneus tertius; by the depression on its posterior part, to the tibialis posticus: the external surface, to the peronei; the posterior surface, to the soleus and flexor longus pollicis; its head, to the biceps flexor cruris.

Developement.—The fibula has an osseous centre for its body, and one for each extremity.

Bones of the Foot.—The foot is composed, like the hand, of three parts, viz. the tarsus, metatarsus, and toes.

Tarsus.—The tarsus is composed of seven bones, viz. the os calcis, astragalus, naviculare, cuneiforme internum, cuneiforme medium, cuneiforme externum, and cuboides.

The Calcaneum.— This bone, (plates XXVIII. XXIX., *os calcis—calcaneum,*) is situated at the posterior and inferior part of the tarsus, and forms the heel by its projection backwards; elongated in that direction, and compressed laterally, it is the largest of the bones of the foot. Superiorly it presents (taking the objects successively from behind forwards) a concave portion, intervening between the insertion of the tendo Achillis into its posterior border, and the surface which articulates with the astragalus; then the last-named surface, which is bounded by a rough depression for the insertion of a ligament (interosseous); and lastly a narrow concave surface, which also articulates with the astragalus. On the inferior surface, which is narrower than the preceding, and broader behind than before, are observed posteriorly two tubercles, (the internal being the larger,) serving for the attachment of the plantar fascia and the superficial plantar muscles; between them a depression for the origin of the long plantar ligament, and in front another eminence, giving attachment to the inferior ligament (calcaneo-scaphoid) connecting this bone with the scaphoid. The anterior surface, the smallest, is slightly concave, and articulates with the cuboid bone. The posterior surface, convex, presents, inferiorly, inequalities, for the attachment of the tendo Achillis; and, superiorly, a smooth surface, separated from that tendon by a synovial bursa.

the bone. On the sides, and above this, are two rounded eminences (*tuberosities*), the external one being somewhat smaller than the other, and marked posteriorly by a flat surface, which articulates with the head of the fibula; these processes give attachment to the lateral ligaments of the knee-joint. On the superior aspect of this portion of the bone may be observed two concave cartilaginous surfaces, (*condyles,*) which sustain the condyles of the femur; the internal one is somewhat the deeper, its greatest diameter is from before backwards; the external one is nearly circular. In the interval between the articular surfaces is situated a pyramidal eminence, the summit of which is usually divided into two tubercles; it is named the spine or spinous process of the tibia; before and behind this are two irregular depressed surfaces, which give attachment to the crucial ligaments and to the semi-lunar cartilages.

The *lower* or *tarsal* extremity of the bone is much smaller than the upper, and nearly quadrilateral in its form; the anterior surface, convex and smooth, is bounded below by a slightly rough margin which gives attachment to the anterior tibio-tarsal ligament; the posterior is flat, and marked by a groove for the flexor longus pollicis; the external, slightly concave, is rough superiorly, for the attachment of the transverse ligament, and smooth below, to receive the extremity of the fibula. From the inner border of this end of the bone projects downwards a triangular apophysis, the *internal malleolus;* the inner surface of which is convex, and covered merely by the skin, the external is smooth, and articulates with the side of the astragalus; the anterior forms a rounded border, whilst the posterior is marked by two grooves for the tendons of the tibialis posticus, and flexor longus digitorum; to the most dependent part of the process is attached the internal lateral ligament. The lower articular surface of the tibia, or that part which enters into the formation of the ankle-joint, consists of two parts, one vertical, just described as being situated at the outer side of the malleolus; the other horizontal in its direction, concave and quadrilateral in its form, divided into two parts by a slightly raised line; of these two surfaces, which are united at a right angle, and tipped with cartilage in the fresh state, the latter rests on the dorsum of the astragalus, the former is applied to its inner flat border.

The *body* of the tibia, triangular in its form, diminishes gradually in size for about two thirds of its length, after which it increases somewhat towards its lower extremity. The internal surface is convex and subcutaneous, except at the upper part of its extent, where it is covered by the tendons of the sartorius, semi-tendinosus, and gracilis muscles. The external surface, slightly hollowed above, where it gives origin to the tibialis anticus, is convex, and somewhat inclined forwards below, where it is covered by the extensor tendons. The posterior surface is very deeply seated; not so uniform in its outline as the others, it is marked at its upper third by a line extending upwards and outwards to the external tuberosity; the part above this is triangular, and gives attachment to the popliteus muscle, that below it to the tibialis posticus and flexor digitorum, and from the line itself arises the soleus. Near this line may be observed a medullary foramen of large size, whose direction is from above downwards.

The surfaces here indicated are separated by an equal number of borders. The anterior border, more or less sinuous in direction, sometimes considerably curved, is for the most part subcutaneous; sharp and prominent, especially towards the middle, and hence named the *crista* or *spine* of the tibia, it subsides towards the lower end of the bone, as if to allow a smooth surface for the passage forwards of the vessels and muscles, which superiorly are placed on the outer side. The inner border, thick and rounded, gives attachment to the soleus and flexor longus digitorum; whilst the external, somewhat sharp, divides inferiorly into two lines, which diverge towards the surface of articulation with the fibula. The interosseous ligament is inserted into this external border. The body of the tibia is slightly twisted, so that the internal tuberosity inclines a little backwards, and the internal malleolus forwards, which conformation deserves attention in the diagnosis and adjustment of fractures.

Articulations.—The tibia articulates with the femur, the fibula, and the astragalus.

Attachments of muscles.—To the external surface and external tuberosity, the tibialis anticus; to the latter also, the head of the extensor longus digitorum; to the inner surface, the sartorius, gracilis, semi-tendinosus, and semi-membranosus; the popliteus, to the triangular space on the posterior surface; the soleus, tibialis posticus, and flexor longus digitorum, to the rest of its extent, and, through the medium of the patella and its ligament, it may be said to give insertion to the extensors of the leg.

Developement.—There is an osseous centre in the body of the bone, and one at each extremity.

The Fibula.—This bone (plate XXVI., *fibula, peroné,* περονη, a clasp,) is situated at the external

side of the leg; it is nearly equal to the tibia in length, but is much more slender. When the fibula is placed beside the tibia in its natural position, its lower extremity will be found a little farther forward than the upper one, and its shaft inclined backwards and a little inwards, so as to be convex in that direction.

The *body* of the bone, irregularly triangular in its form, presents three prominent lines bounding three surfaces; the anterior, or most prominent line, gives origin to muscles in the superior part of its extent, and bifurcates towards its lower extremity, so as to enclose a slightly concave triangular surface, which is subcutaneous; the internal one also gives attachment to muscles, and inferiorly, where it inclines forwards, to the interosseous ligament. The *internal* surface looks backwards for about a third of its extent, and somewhat forwards in the rest, and is divided, but unequally, into two parts, by a slightly-marked longitudinal line, to which the interosseous ligament is attached for about two-thirds of its length; the part of the surface behind this is grooved,—it gives attachment to the tibialis posticus muscle; the anterior portion, the smaller, to muscles placed in front of the leg. The *external* surface, concave in the greatest part of its extent, gives origin to muscles;—towards its lower extremity, this surface is inclined backwards, conforming with the peronei muscles, which are connected with the superior part of the bone, and incline in that direction to pass behind the external malleolus. The *posterior* surface, convex and smooth, affords attachment to muscles, and presents towards its middle a small foramen, directed obliquely downwards for the transmission of the medullary vessels; in the lower part it inclines inwards, and is terminated by a rough surface connected with the tibia.

The *superior* extremity of the bone, called also the head, is smaller than the inferior one; it presents on the supero-internal part a small oval and nearly flat surface, for its articulation with the corresponding part of the external tuberosity of the tibia; the remainder is unequal, and gives insertion to the biceps flexor cruris, to the external lateral ligament of the knee-joint, and to those which connect the tibia and fibula. The *inferior* or tarsal *extremity* forms the external malleolus, which is longer and more prominent than the internal one; in front it receives the insertion of ligaments; behind is situated a shallow groove traversed by the tendons of the peronei muscles; the outer side is convex and subcutaneous; the inner presents a small triangular surface, convex in the perpendicular, and nearly plain in the antero-posterior direction, which articulates with the astragalus, and is bounded posteriorly by a rough depression, affording attachment to the transverse ligament of the ankle-joint, whilst the apex gives origin to the external lateral ligament.

Articulations.— The fibula articulates at both extremities with the tibia, and at the inferior one with the outer border of the astragalus.

Attachments of muscles. — The internal surface, by its anterior portion, to the extensor communis digitorum, extensor proprius pollicis, and peroneus tertius; by the depression on its posterior part, to the tibialis posticus: the external surface, to the peronei; the posterior surface, to the soleus and flexor longus pollicis; its head, to the biceps flexor cruris.

Developement.—The fibula has an osseous centre for its body, and one for each extremity.

Bones of the Foot.—The foot is composed, like the hand, of three parts, viz. the tarsus, metatarsus, and toes.

Tarsus.—The tarsus is composed of seven bones, viz. the os calcis, astragalus, naviculare, cuneiforme internum, cuneiforme medium, cuneiforme externum, and cuboides.

The Calcaneum.— This bone, (plates XXVIII. XXIX., *os calcis—calcaneum,*) is situated at the posterior and inferior part of the tarsus, and forms the heel by its projection backwards; elongated in that direction, and compressed laterally, it is the largest of the bones of the foot. Superiorly it presents (taking the objects successively from behind forwards) a concave portion, intervening between the insertion of the tendo Achillis into its posterior border, and the surface which articulates with the astragalus; then the last-named surface, which is bounded by a rough depression for the insertion of a ligament (interosseous); and lastly a narrow concave surface, which also articulates with the astragalus. On the inferior surface, which is narrower than the preceding, and broader behind than before, are observed posteriorly two tubercles, (the internal being the larger,) serving for the attachment of the plantar fascia and the superficial plantar muscles; between them a depression for the origin of the long plantar ligament, and in front another eminence, giving attachment to the inferior ligament (calcaneo-scaphoid) connecting this bone with the scaphoid. The anterior surface, the smallest, is slightly concave, and articulates with the cuboid bone. The posterior surface, convex, presents, inferiorly, inequalities, for the attachment of the tendo Achillis; and, superiorly, a smooth surface, separated from that tendon by a synovial bursa.

The external surface, broader behind than before, presents in the latter direction, superficial grooves, for the tendons of the peronei muscles, and is subcutaneous in the rest of its extent. The inner surface, deeply concave, is traversed by the plantar vessels and nerves, and the tendons of the flexor muscles. A groove runs along at its upper edge, and under the tubercle which surmounts it, for the tendon of the flexor longus pollicis. The calcaneum articulates with the astragalus and the cuboid bone.

The Astragalus (αστραγαλος, a die).—The astragalus [plates XXVIII. XXIX.] is situated at the superior part of the tarsus; its form is irregular, it appears as if twisted on itself. The upper surface presents, in front, a rough and slightly excavated part, serving for the attachment of ligaments; and behind it a large convex cartilaginous surface, which is longer and more prominent on the outer than on the inner side, broader before than behind, and articulated with the lower extremity of the tibia. On the outer and inner sides are situated two smooth surfaces, (the former the larger,) which are continuous with the preceding, and articulated with the inferior extremities of the tibia and fibula (the *malleoli*). On the inferior surface are observed, in front, and somewhat internally, a narrow convex surface, and behind, a broad concave one, both articulating with the os calcis; these are separated by a groove, which receives the ligament that proceeds upwards from the last-named bone. The anterior surface, convex, is received into the hollow in the scaphoid bone; it is called the *head*, and the constricted part by which it is supported, the *neck* of the astragalus. The posterior surface, or rather border, is grooved and traversed by the tendon of the flexor longus pollicis. The astragalus articulates with the tibia and fibula above, with the os calcis below, and with the scaphoid in front.

The Cuboid bone.—This bone (*os cuboides, cuboideum*) [plates XXVIII. XXIX.] is situated at the external side of the tarsus; its form is indicated by its name. The superior surface, rather rough, inclined obliquely outwards and upwards, gives attachment to ligaments. The inferior surface presents, in front, a depression traversed by the tendon of the peroneus longus muscle, in the middle a transverse ridge, (tuberosity,) and behind it an irregular surface, both of which give attachment to the calcaneo-cuboid ligament; the former also to some fibres of the ligamentum longum plantæ. At the anterior aspect of the bone is a smooth surface, directed from without inwards and forwards, and divided into two parts, the internal one being square, the external triangular, and articulated, the former with the fourth, the latter with the fifth metatarsal bone; at the posterior is a surface by which it articulates with the os calcis. The external border, which is short and rounded, presents a groove, continuous with that on the inferior surface, and serving for the transmission of the tendon of the peroneus longus muscle. On the internal surface may be observed, towards its middle, an elongated smooth and nearly flat portion, which articulates with the third cuneiform bone, the part before and behind it being rough, for the attachment of ligaments. The cuboid articulates with the fourth and fifth metatarsal bones before, with the os calcis behind, with the external cuneiform, and sometimes with the scaphoid.

The Scaphoid bone.—The scaphoid or navicular bone, [plates XXVIII. XXIX.] so named from its excavated form, (σκαφη, *navis*,) is placed at the inner border of the foot, between the astragalus and the cuneiform bones. It presents a concave surface which looks backwards, and a convex one which is turned forwards. Its inner margin projects in the form of a tubercle toward the sole of the foot. Upon its upper and inner surface are inequalities for the attachment of ligaments,—behind, a concavity for the head of the astragalus,—in front, three distinct surfaces for articulation with the three cuneiform bones; at its lower and inner border is the prominence or tubercle, above noticed, which gives attachment to the tibialis posticus muscle; on the outer side, in some instances, is a small articular surface, by which it is united to the cuboid bone. It articulates with the three cuneiform bones, with the astragalus, and sometimes with the cuboid.

The Cuneiform bones.—These bones [plates XXVIII. XXIX.] (*ossa cuneiformia*, wedge-shaped,) constitute the anterior and inner part of the tarsus; the name expresses their form. In number three, they are distinguished by their numerical order from within outwards. The first is the largest, and has its base or broad border turned down into the sole of the foot,—the second, or middle, the smallest. The base, or broad border, of the second and third is at the upper or dorsal surface of the foot, and contributes to give it its arched form. They articulate behind with the navicular, and in front with the first, second, and third metatarsal bones. In consequence of their excess in length over the second, the first and third, in addition to articulating laterally with the corresponding sides of that bone, are in apposition with the base of the second metatarsal bone, which is inserted between them. The inner side of the first is subcutaneous, and the

outer side of the third articulates by a smooth flat surface with the cuboid, and by a small linear facette with the fourth metatarsal bone.

Attachments of muscles.— The os calcis, by its dorsal surface, to the extensor brevis digitorum pedis; the inferior half of the posterior surface, to the common tendon of the gastrocnemius and soleus (*tendo Achillis*), and to that of the plantaris; the inferior surface on the inner side, to the flexor accessorius, and part of the abductor pollicis; on the outer side, to the abductor digiti minimi; and between the two abductors, to the flexor brevis digitorum.

The cuboid bone, by the inferior surface, to a portion of the adductor pollicis.

The scaphoid bone, by its tuberosity, to a portion of the tendon of the tibialis posticus.

The cuneiform bones. The first, by its base, to portions of the tendons of the tibialis anticus and posticus, and the second and third to part of the flexor brevis pollicis.

Developement.— These bones have each a separate centre of ossification. The os calcis has a second in its posterior part or tuberosity.

The Metatarsus.— The second or middle portion of the foot [plate XXVIII.] is analogous to the corresponding portion of the hand (metacarpus), and like it is composed of five bones placed parallel one with the other. They are named according to their numerical order, from within outwards. The first, or that supporting the great toe, is the shortest, but it exceeds all the others very considerably in thickness. The second is the longest, and the rest decrease successively in length. In all, the thickness of the extremities, particularly of the tarsal ends, is greater than that of the bodies. The bodies of these bones elongated and somewhat compressed, like the metacarpal bones, may be considered as presenting a dorsal, a plantar, and two lateral surfaces. The dorsal surface of all is covered by the tendons of the extensor muscles, the extensor brevis digitorum, and the vessels and nerves; that of the first is broad, inclined inwards, and bounded externally by a prominent line; in the last it looks outwards, and is bounded on the inner side by a like line. In the others are observed analogous lines, placed in the middle, and separating the attachments of the interossei muscles. The plantar surface corresponds to the deep-seated muscles of the foot, and to ligaments serving to connect those bones. That of the first is broader than any of the others. The lateral surfaces form the interosseous spaces, and give attachment to the interosseous muscles. The tarsal extremity presents, in the first, an oval concave surface, broader above than below, articulating with the first cuneiform bone, and inferiorly a tuberosity for the attachment of the peroneus longus; that of the second metatarsal bone, triangular in its form, is, in consequence of the shortness of the corresponding cuneiform bone, impacted between the two other bones of that name; it gives attachment to ligaments, articulates behind with the second cuneiform bone, on the inner side with the first metatarsal bone, and on the outer with the second. The tarsal end of the third, also triangular, and smaller than the preceding, receives the insertion of ligaments on its upper and under surfaces, and articulates posteriorly with the third cuneiform bone, on the inner side with the second metatarsal bone, on the outer with the fourth. The extremity of the fourth metatarsal bone, cubical in its form, is connected by ligaments to the adjacent bones, and articulates with the cuboid posteriorly, on the inner side with the third metatarsal and third cuneiform bones, on the outer with the fifth metatarsal. The posterior extremity of the fifth metatarsal bone, pyramidal in its form, articulates behind, by an oblique surface, with the cuboid, and on the inner side with the fourth metatarsal bone; on its external and lower side is a rough tuberosity, which forms a considerable projection on the external border of the foot, and gives attachment to the peroneus brevis, and to part of the abductor minimi digiti.

The anterior extremities of the metatarsal bones are convex, and rounded into the form of heads, flattened at the sides and elongated from above downwards. The head is bounded by a groove, or neck, better marked on the upper than on the under surface. These extremities are received into shallow depressions in the first phalanges, with which they are articulated.

Phalanges of the Toes.—The toes, which form the last part of the foot, are composed each of three phalanges or rows, except the first, which has but two. The body of the *first* presents three surfaces: one inferior, or plantar, is flat; the others, lateral, are smooth and convex, and meet on the dorsum in a rounded border; they are contracted towards the middle, somewhat rough and broad at the extremities for the attachment of ligaments; concave towards the sole of the foot, and convex superiorly. The posterior extremities, broader than the anterior, are concave, and receive the head of the metatarsal bones. The anterior terminate in two rounded heads, with an intervening pulley-like surface, the lateral parts being received into depressions, in the contiguous extremities of the second phalanges, whilst the middle groove lodges a prominent line marked on the latter.

The bones of the *second phalanx*, much smaller than the first, are somewhat hollowed on the lower surface, and convex on the upper one; their borders are flat and compressed. The posterior extremities are terminated by two small concave articular surfaces separated by a prominent line, by which means they are adapted to the inequalities observed on the contiguous extremities of the first phalanges. The anterior extremities present two small condyles, which articulate with the third phalanges.

The third set are somewhat conical in their figure; the posterior extremities, or base, being hollow for their articulations with the ends of the second phalanges, whilst the anterior is rough and scabrous.

Attachments of muscles.—To the metatarsal bones. The *first* gives attachment to the prolonged tendon of the peroneus longus, to the transversalis pedis, and the first dorsal interosseous muscle; the *second*, to the first and second dorsal interossei; the *third*, to part of the adductor pollicis, to three interossei, and part of the transversalis pedis; the *fourth*, to three interossei also; the *fifth*, to the peroneus brevis and tertius, the transversalis pedis, part of the flexor brevis minimi digiti, to the fourth dorsal and third plantar interosseous muscle.

To the bones of the toes. The *first* phalanx of the great toe gives insertion to the abductor, flexor brevis, and adductor pollicis; the *second* phalanx, to the extensor proprius pollicis and flexor pollicis longus; the *second* phalanges of the other toes receive the insertion of the tendons of the flexor sublimis; and the *third*, those of the flexor profundus and of the extensors.

Ossa Sesamoidea.—These do not properly form part of the skeleton; they may be considered as accessories to the tendons of muscles, and are found only in the limbs, never in the trunk. In the superior extremity, two are always found in the articulation of the metacarpal bone of the thumb with its first phalanx. In the lower extremity, two are frequently found behind the femoral condyles, and constantly beneath the first joint of the great toe, as well as in the tendons of the tibialis posticus and peroneus longus. They are situated in the direction of flexion (the only exception being the patella, which belongs to this class of bones), and serve the purpose of increasing the power of muscles, by removing them farther from the axis of the bone on which they are intended to act.

LIGAMENTOUS SYSTEM.

Articulations.—The different pieces of the osseous system being connected together so as to form a skeleton, their modes of union must be as various as their forms and uses. When the union is not immediate, as is the case in the cranial bones, it is effected by means of different substances, such as ligament, cartilage, fibro-cartilage, and fibrous membrane, variously arranged and disposed, so as to permit, in some instances, no perceptible motion; whilst in others a free and extended range is allowed in every direction. Still, all the varieties, however numerous, are usually included under the general term "articulation."

The articulations are divided into three classes, viz. the immovable, the movable, and mixed; the last being intermediate in degree between the others. The first form obtains where flat and broad bones are united to enclose cavities for the lodgment of important organs, as in the cranium and pelvis. In some instances the surfaces are indented and reciprocally impacted one into the other, so that complete solidity is insured by the structure of the part; and as this mode of union occurs only amongst flat bones, their deficiency in extent of contact is compensated by the indentations in their margins. There is another set of immovable articulations, in which the surfaces are merely in apposition with one another, yet total immobility is secured by what may be termed a mechanical contrivance. Thus, though the squamous part of the temporal bone merely rests against the inferior border of the parietal, no motion can exist between them, in consequence of the manner in which the petrous portion of the former bone projects into the base of the skull.

All the bones of the head and face, except the lower jaw, are joined by immovable articulation, or *synarthrosis* (συν, *together*; αρθρον, *articulation*), of which there are several forms.

1. The first is called *suture* (sutura, *a seam*). In the true suture the union is effected by indentations in the contiguous margins of bones which are mutually received into one another, as may be seen between the two parietal, the occipital, and frontal bones; any varieties that occur being referable to the form of the prominences. Thus, when they are tooth-shaped, the suture is termed *sutura dentata*; if like the teeth of a saw, *sutura serrata*; if the adjacent borders be bevelled off, as where

the temporal and parietal bones are applied to one another, it is called a squamous suture (*sutura squamosa*). In some parts it may be observed that the mode of union and adaptation are alternated, in order to increase their power of resistance. Thus, at the superior part of the arch of the skull, the frontal overlies the parietal bones, and rests on them; but inferiorly and laterally the reverse takes place, where the parietal rests against the frontal.

When the surfaces are merely placed in apposition with one another, as in the superior maxillary bones, the union is called *harmonia* (ἁρμω, *to adapt*).

When a ridge in one bone is received into a groove in another, the articulation is called *schindylesis* (σχινδυλησις, a *slit* or *fissure*). The rostrum of the sphenoid, and the descending plate of the ethmoid bone, are joined in this way with the vomer. When a conical surface is impacted into a cavity, the term *gomphosis* (γομφος, *a nail*) is adopted, which may be exemplified by the manner in which the teeth are lodged in the alveoli.

In the mixed form of articulation, or *amphi-arthrosis,* the bones are connected by an intermediate substance, which allows some degree of motion. The articulations between the bodies of the vertebræ, the union of the pubic symphysis, and that between the two first bones of the sternum, are all constructed on this principle. As the surfaces in these cases are flat and plain, they possess in themselves no mechanical advantage; so that their union is maintained partly by the cartilages interposed between them, and partly by ligamentous and fibrous structures disposed round the articulations.

In the movable articulations, or *diarthrosis* (δια, *through;* αρθρον, *articulation*), as the surfaces are merely in contact with one another, the connexion between the parts is maintained by means of ligaments and fibrous membranes; for, though cartilages are interposed between their adjacent extremities, they do not form a bond of union between them; on the contrary, they are calculated to facilitate motion, rather than to restrain it. But the muscles which surround the different movable articulations contribute materially to retain the articular surfaces in their natural situations, and to prevent displacement. This is particularly evident in the shoulder-joint, in which the head of the humerus is kept in contact with the glenoid cavity of the scapula not so much by the fibrous capsule, which is weak and loose, as by the surrounding muscles; for if these be weakened by paralysis, luxation may be readily produced. The joints in the extremities are all referable to the movable class; so is that of the lower jaw with the skull, and of the latter with the vertebral column. In the greater number of instances one of the articular surfaces is convex, the other concave; but each of these forms exhibits some varieties of conformation, which are marked by particular names. Thus, an articulating surface, which is rounded and globular, so as to represent a segment of a sphere, is called a *head;* but, if it be elongated, the term *condyle* is used. These are in some cases supported by a contracted or thin portion (*neck*), which connects them with the body of the bone. If two condyles be placed in apposition, so as to leave a fossa between them, and constitute a pulley-like surface, it is termed *trochlea.* When plain even surfaces articulate, it is not necessary to mark them by any particular name; in describing them they are referred to generally as articulating surfaces. Some of the articulating depressions have also received names taken from certain peculiarities in their conformation. Thus, the superior extremity of the ulna, which receives the trochlea of the humerus, is called the sigmoid cavity, from some resemblance to the Greek letter Σ (σιγμα, ειδος, *like*); others are denominated from their greater or less degree of depth or shallowness. The deep cup-shaped cavity which receives the head of the femur is called cotyloid (from κοτυλη, *a cup,* and ειδος, *like*); and the shallow oval depression to which the head of the humerus is applied, receives the name of *glenoid* cavity (from γληνη, *a shallow cavity,* and ειδος, *like*).

The varieties of diarthrosis are:—1. *Enarthrosis* (εν, *in;* αρθρον, *a joint*), which in common language is called the "ball-and-socket" joint; such as we see in the hip and shoulder. In these great freedom of motion is provided for.—2. *Arthrodia,* which comprises joints with a limited motion, as in the case of the carpal and tarsal bones, which merely slide for a little way upon each other. The articulations between the tubercles of the ribs and the transverse processes of the vertebræ, and those between the articular processes of the last-named bones, also come under this head.

As the extent and form of the articulating surfaces of joints, as well as their ligamentous connexions, vary in different instances, so must their degrees of solidity and mobility: and, on a review of the whole of the articulations, it may be laid down as a general principle, that the greater their mobility, the less their solidity; or, in other words, that the one is inversely as the

other. All the motions, however, which are admissible in joints may be arranged under four heads, viz. motions of gliding, angular movement or opposition, circumduction, and rotation.

1st. The contiguous surfaces of every movable articulation admit a certain degree of *gliding* motion upon one another, so that it may be regarded as common to all; but in some cases it is the only one which takes place, for instance, between the different bones of the carpus and tarsus. We thus observe that some joints admit of all the motions here indicated; some are deprived of rotation, retaining the rest; whilst in others nothing more than a mere gliding can take place between the surfaces; so that a regular gradation is established in their degrees of mobility between the most movable and those which are least so. The shoulder-joint admits of the greatest extent and variety of movement; those between the carpal and tarsal bones are exceedingly limited in these particulars; and finally, between the latter and those which are altogether immovable, an intermediate grade may be traced, of which the pubic symphysis presents an example.

2nd. The *angular* movement, or opposition, can only take place between long bones. If these be made to move in opposite directions, as from extension to flexion, or from abduction to adduction, they form with one another angles varying in degree according to the extent of the motion. This, in some cases, as in the elbow and knee, is confined to flexion and extension, which makes them strictly ginglymoid or hinge-joints (*γιγγλυμος*, a hinge); in others the motion is general, and extends to four opposite directions, including each of the points intermediate between them, as may be observed in the shoulder, in the hip, and the metacarpal joint of the thumb, all which joints admit of a circumduction in the part to which they belong.

3rd. The motion of *circumduction* is performed when the shaft of a bone is made to describe a cone, its summit corresponding with the superior articulation, the base being at the inferior extremity of the bone. While this motion is being executed, the limb passes successively through the states of elevation, abduction, depression, adduction, and of course through all the intermediate points; and if a pencil be held between the fingers, and its point applied to any plain surface, such as a wall, it will trace a circle corresponding with the base of a cone, whose summit is at the shoulder-joint, whilst its side coincides with the line described by the out-stretched limb as it traverses the different points just enumerated.

4th. *Rotation* differs altogether from circumduction. In the latter the bone suffers a change of place as it moves from one point to another; in the former, it merely turns on its own axis, and therefore retains the same relative situation with respect to the adjacent parts. This movement, however, admits of two varieties; in one, it is performed on a pivot, as in the motion of the axis on the vertebra dentata; in the other there is a sort of compound motion, for instance, where the radius rolls on its own axis at one end, whilst at the other it moves upon the extremity of the ulna, by which its lower part describes a segment of a circle, and therefore changes place to a certain extent. The femur and humerus also admit of a rotatory motion; in the latter, as the head is closely applied upon the shaft, the axis of motion nearly coincides with that of the bone; but in the former, in consequence of the length of the neck, and of the angle which it forms with the bone, the rotation is performed round an imaginary axis, which may be conceived to pass from the globular head to the condyles.

There are but two articulations in which all the motions of opposition, circumduction, and rotation can be performed, namely, the hip and the shoulder joint. In these a convex surface is applied to one which is concave, the former being hemispherical, which is essentially necessary to such a freedom of motion. As joints constructed on this principle are more liable to displacement than any others, their security is in a great measure provided for by their being placed at the superior extremity of the limb, by which they are withdrawn from the influence of external forces. This arrangement is made subservient, not to the security of the joint solely, but also to a very important purpose in the functions of the limb; for, as these free and extended motions are performed in the superior articulation, their effect is communicated to the whole limb, so as to compensate for the more restricted movements in the lower joints.

Though all the motions above mentioned take place in the hip and shoulder joints, each of them, considered singly, is not performed with equal facility in both. Thus, circumduction is executed with greater ease in the shoulder than in the hip. Rotation, on the contrary, is more free and perfect in the latter than in the former. Circumduction can be executed with ease only when the axis of motion coincides (or very nearly so) with that of the lever to be moved, as is the case in the humerus; but, in the femur, the length of the neck of the bone removes the axis of motion considerably from that of the shaft, and thereby impedes circumduction in proportion as it

facilitates the rotation of the limb. These differences of structure in the superior joints of the two extremities bear a direct relation to the conformation of their other articulations, and to the purposes for which they are adapted. For, as the inferior extremity is intended to sustain the weight of the body and for progression, the bones of the leg must be securely fixed, which could be effected only by diminishing their mobility; on this account no rotation or supination is allowed between the tibia and fibula; but, to compensate for this deficiency, rotation is permitted in the hip. But as the superior extremity, on the contrary, is fitted for the prehension of objects, and for quick and varied movements, free motion is allowed between the bones of the fore-arm, and between the latter and the carpus, in order that the hand and fingers may be more readily directed and applied to such objects as are required to be seized for different purposes; and the power of pronation and supination, thus conferred, more than compensates for any deficiency in the rotatory motion of the humerus.

It has been already observed, that rotatory motion in a bone presupposes the existence of a globular head, placed so that its axis shall form an angle with the shaft. Wherever this requisite is wanted, motion is confined to opposition and circumduction, as occurs in the articulation of the thumb with the carpus, in the phalanges with the metacarpal bones, and in the clavicle with the sternum. In these joints, the articulating surfaces are placed at the ends of the more movable bones; and, as their axes coincide with that of motion, rotation is prevented; but circumduction and opposition are freely performed. When these are limited in extent, as in the sterno-clavicular articulation, it arises rather from the accessory ligaments of the part than from any impediment in the surfaces of the bones; and if motion in one direction be more free than in another, as in the digital phalanges with the metacarpus, where flexion and extension are more free than abduction and adduction, it proceeds partly from the existence of the lateral ligaments, and partly from the great power possessed by the flexor and extensor muscles compared with those which perform the other movements. Though in the knee and elbow the axis of motion coincides with that of the bones, yet their movement is confined to two directions, viz. to flexion and extension. In these joints all other motions besides those just mentioned are prevented by the breadth of the articulating surfaces, and by their mode of adaptation: however, when they are flexed, some degree of lateral motion, and also of circumduction, can be performed; as any individual may ascertain by resting his elbow on a table, when he will find that the fore-arm may be made to describe a cone with its summit at the olecranon and base towards the fingers.

The structures entering into the composition of the articulations, are ligaments, fibro-cartilage, cartilage, elastic fibrous tissue, and synovial membrane.

Ligaments (ligamenta; λειγω, to bind) form the chief means by which the numerous pieces of the osseous system are bound together, so as to constitute one whole—the skeleton. Their form and size must vary considerably in different parts, some being flat bands, some rounded cords, and others short but wide tubes, attached at both ends to bones which admit of free movement upon one another, as we see in the capsular ligaments of the hip and the shoulder. Viewing ligaments in this way, we may divide them into two groups, the funicular or cord-like, and the capsular; they are also called, from a mere consideration of their position in relation to their respective joints, anterior and posterior, internal and external, lateral. Most ligaments enter into the formation of joints, and are therefore articular; some, however, merely fill up spaces, as the interosseous ligaments in the fore-arm and leg; or connect parts between which no motion exists, at the same time that they diminish vacuities, of which the sacro-sciatic, and the two proper ligaments of the scapula, furnish examples. The term "false ligament" is frequently applied to certain folds of serous and synovial membranes, from their being supposed to confine the parts to which they are attached. The broad processes of peritonæum extended from the bladder and uterus to the sides of the pelvis, also the so-called ligamentum mucosum in the knee-joint, may be cited as instances: the expression is obviously ill-chosen, and should be discontinued.

Fibro-cartilage, as the name implies, is a structure intermediate between fibrous tissue and cartilage, and partakes of the qualities of both, viz. firmness and elasticity. Being calculated to serve different purposes in the economy, it presents not a few varieties both of appearance and structure. Thus, we find it in the form of broad thin plates in the pieces of the larynx and epiglottis, in the pinna of the ear, in the lateral and median cartilages of the nose, and in the tarsal cartilages of the eye-lids; for in these parts it forms their basis of support, and determines their form; whilst in the trachea it consists of narrow plates curved round the tube, forming a series of rings. In the immovable articulations, fibro-cartilage is interposed between the contiguous surfaces of bones, in layers of various forms and thickness, constituting in some instances the principal

means of connecting them together, as we see at the junction of the ossa pubis, and also of the bodies of the vertebræ, in which instances the elastic property is of considerable utility. In some of the movable articulations, pieces of this structure are also placed, their form and size necessarily varying in each instance. In the knee-joint,—in the articulation of the lower jaw-bone, and in that of the clavicle with the sternum, they diminish the effects of jarring motions by their elasticity, and by a certain degree of mobility, which allows them to give way as the bones move upon them, they keep up a perfect adaptation between the parts, notwithstanding the many inequalities of their surfaces. In the hip and shoulder joints they are so disposed as to deepen the articulating cavities, and lessen the liability to dislocation.

Cartilage (cartilago, tissu cartilagineux, χονδρος) is much more dense and solid than any of the preceding textures; it is highly elastic, and by its resiliency resumes its original position when any compressing force, to which it may be exposed, is removed. Its colour is in general a silvery white, and not unfrequently presents that of mother-of-pearl; its density is such, that all trace of its cellular nature, or of its being a modification of cellular tissue, is lost. Mr. Hatchett considers its chemical composition to be albumen, and a small quantity of phosphate of lime. It contains a considerable quantity of water, consequently soon dries on exposure to the air, becomes yellow, semi-transparent, and loses its elasticity; it resists maceration, and the action of cold water, for a long time, but is soon acted on by acids, or by boiling water, and converted into a gelatinous pulp.

Cartilage serves as an adjunct to bone, or a substitute for it. In early infancy the different pieces of the skeleton are cartilaginous; but, in the progress of growth, bone becomes deposited in their place, and gradually supplants them altogether; such cartilages are termed *temporary*. The articulating extremities of bones are covered with layers of cartilage, not merely to smoothen them, but also, by their elasticity, to lessen the effects of concussion. The thickness of these layers varies from half a line, or even less, to two lines; it will generally be found greatest along the margins of concave surfaces, and towards the centre of those which are convex. The free surface of each articular cartilage is covered by the synovial membrane of the joint, from which it is impossible to separate it; the attached surface is in equally intimate union with the bone on which it rests.

The *costal* cartilages form so many elastic prolongations of the ribs, serving not merely to complete the arch from the spine to the sternum, but also, by means of their elasticity, to restore the ribs to their original position, after having been elevated by the effort of inspiration.

Elastic fibrous tissue (tissu jaune élastique—tissu fibreux jaune,—ligamenta flava—subflava) consists of pale yellow fibres placed parallel, whether their general direction is perpendicular or oblique, no decussation or crossing being observed between them; they are easily separable from one another, as but little cellular tissue connects them. As its name implies, elasticity is the chief property of this structure wherever it occurs, being developed to such a degree as to render it well calculated to form suspensory ligaments, or to invest parts which are subject to considerable alternations of distension and contraction. Thus, in quadrupeds a strong band of elastic tissue (*ligamentum nuchæ*) extends from the spinous processes of the neck, and from some of those of the back, to the skull, the weight of which it supports without producing that sense of fatigue which would necessarily arise were muscle the sustaining power. The corresponding structure in man is reduced to a rudimentary state, the balanced position of the head on the spinal column rendering any further provision unnecessary. The same material enters into the composition of the ligaments which connect the arches of the vertebræ (*ligamenta subflava*).

Synovial membrane (membrana synovialis, tissu synovial).—Under this head are included the lining membranes of all the articulations in the body, together with a great number of secreting sacs, (*bursæ mucosæ*,) which occur in various parts, more particularly in those which are subject to motion and pressure. The secretion poured out by both is quite the same, though the names given to them would imply a difference; and the purposes which they serve in the economy are also the same, viz. that of facilitating motion, and preventing the injurious effects of friction, by means of the fluid which they secrete. Synovial membranes, like those of the serous class, are shut sacs, without perforation or interruption of their continuity.

Each *articular* synovial membrane lines the fibrous structures which connect the component parts of the joint, and is reflected over the smooth extremities of the bones. If a tendon passes across a joint, as that of the biceps muscle does in the shoulder, or if a ligament lies within it, as we see in the hip-joint, it is enclosed within a tubular sheath derived from the synovial membrane.

Membranous processes and prolongations are found in some joints, attached by one extremity, the other being loose and floating. They consist of duplicatures of the synovial membrane enclosing some adipose tissue, together with delicate vessels. These were at one time called "glands of Havers," after an anatomist of that name, who supposed them to be of a glandular structure, and to secrete synovia; but this fluid is now known to be produced from the whole surface, and not by any particular glands or follicles. As to the properties of the tissue under consideration, we find it to be, wherever it is situated, soft, thin, pale, and semi-transparent, admitting of distension by the effusion of fluid, as in hydrops articuli, and capable of a slow contraction when absorption takes place. It possesses little or no sensibility in its natural condition, but produces severe suffering when attacked by acute inflammation.

Articulations of the Spine.—The different pieces of the vertebral column are connected together by ligaments, by fibro-cartilage, and in some parts by synovial membranes; the former serving to retain them in their situation, the latter to facilitate motion between the different bones. The bodies are joined by two ligamentous bands, extending the whole length of the chain, and also by the inter-vertebral substances.

1. The *anterior common ligament* [plate VII. figs. 1, 7] (ligamentum commune anterius, Sœmmering; fascia longitudinalis anterior, Weitbrecht) is a strong band of fibres which is placed on the front of the bodies of the vertebræ, and reaches from the axis to the first bone of the sacrum, becoming broader as it descends. It consists of longitudinal fibres which are dense, firm, and well-marked. The superficial fibres extend from a given vertebra to the fourth or fifth below it; the set subjacent to these passes from the body of one to about the third beneath it; whilst the deeper ones pass only from one vertebra to that next it. The fibres are thicker towards the middle of the bodies of the vertebræ than at their margins, or over the inter-vertebral cartilages; by which means their transverse depressions are filled up, and the surface of the column rendered even. It may also be observed that they adhere more closely to the margins of the bones than to the middle of their bodies, and still more closely to the inter-vertebral cartilages. Upon the sides of the vertebræ there are some fibres which are thin and scattered, and reach from one bone to the other.

2. The *posterior common ligament* [plate VII. fig. 3] (ligamentum commune posterius, Sœmm.; fascia longitudinalis postica, Weit.) is situated within the spinal canal, and attached to the posterior surface of the bodies of the vertebræ, extending from the axis to the sacrum. It is smooth, shining, and broader opposite the inter-vertebral cartilages than opposite the bodies of the bones, so that its margins present a series of points or dentations with intervening concave spaces. In the greater part of its extent it adheres firmly to the fibro-cartilages and to the bodies of the vertebræ, and is separated by loose cellular tissue from the prolongation of the dura mater which lines the canal.

3. The *inter-vertebral substance* (ligamenta inter-vertebralia, Weit.) is a plate or disc of fibro-cartilage, [plate VII. figs. 5, 6,] placed between the bodies of each pair of vertebræ, from the axis to the base of the sacrum. They correspond in shape to the parts of the vertebræ between which they are interposed, and, like them, increase in thickness from the upper to the lower end of the column. The thickness of these plates is not, however, uniform in their entire circumference. As they contribute to the production and maintenance of the curves which naturally exist in the spine, they are thinnest anteriorly, in the dorsal region, where its concavity looks forward, and, on the contrary, thicker in front, in the neck and loins, where the convexity of the column looks in that direction. They are covered anteriorly and posteriorly by the common ligaments, which are intimately adherent to them; in the dorsal region they are connected laterally, by short ligaments, to the heads of all the ribs, which articulate with two vertebræ. The inter-vertebral substance is composed, towards its circumference, of thin plates of fibro-cartilage, resting on their edges, and placed one within the other, as it were, concentrically. Thus the outer plate like a rim runs round the disc, its lower edge resting on the vertebra beneath it; its anterior or convex surface being subjacent to the anterior common ligament, whilst its concave surface is in apposition with the plate next within it. They are not, however, so broad as that their upper edges may reach the vertebra above them, nor are they exactly perpendicular; they incline inwards a little, so as to allow other plates to be in a manner piled upon them: each cartilage being in fact composed of two or three tiers of very narrow plates thus disposed. The interstices between the plates are filled by a pulpy and apparently elastic substance; and as the number of the plates gradually decreases towards the centre, whilst the pulpy matter increases, the quantity of the latter is such, that, when the pressure which confines it is taken off by cutting through the inter-vertebral substance, it will rise up so as to assume a conical form.

The *articulating processes* of the vertebræ are connected by irregular fibrous bands (ligamenta

processuum obliquorum, Weit.), forming a capsule outside the synovial membranes. These are longer and more loose in the cervical than in the dorsal or lumbar regions.

The arches, or plates of the vertebræ, are connected by the *ligamenta subflava*, [plate VII. figs. 2, 4,] (ligamenta vertebrarum subflava, Weit.) as their bodies are by the inter-vertebral cartilages. These consist of yellow elastic fibres, almost perpendicular in their direction, as they pass from the inferior border of one arch to the adjacent border of that immediately below it. They extend from the root of the transverse processes at each side backwards to the point where the two arches converge at the origin of the spinous processes, where the margins of each lateral half of the ligament may be observed to be merely in contact. The superior border of the ligament is attached, not to the margin exactly of the arch, but rather higher up on its anterior surface; whilst the inferior border is prolonged a little on the posterior surface, as well as the margin of its corresponding arch. They do not exist between the occiput and the atlas, or between the latter and the axis; common fibrous membrane supplies their place in these two spaces. They are most distinctly seen when the pedicles and arches are detached from the bodies of the vertebræ, so that they may be viewed from within the theca vertebralis. At the posterior aspect of the spine they appear short, and, as it were, overlaid by the arches.

The *articulation of the Spinous processes* [plate VII. figs. 2, 7] is effected by means of the supra-spinous and inter-spinous ligaments. 1. The *supra-spinous ligament* consists of small, compressed bundles of longitudinal fibres, which connect the summits of the spinous processes, and form a continuous chain from the seventh cervical vertebra to the spine of the sacrum. The posterior fibres pass down from a given vertebra to the third or fourth below it; those more deeply seated reach only from one to the next, or the second beneath it. 2. The *inter-spinous ligaments*, thin and rather membranous, extend from the root to near the summit of each spinous process, connecting the inferior border of one with the superior border of that next below it. They exist in the dorsal and lumbar regions only, and are intimately connected with the extensor muscles of the spine. The *inter-transverse ligaments* are found only between the transverse processes of the inferior dorsal vertebræ, and even there very indistinctly, for they are united so intimately with the sacro-lumbalis muscle, that their fibres are quite confused.

Articulations of the two upper Vertebræ.—The articulation of the axis with the atlas [plate VIII. figs. 1—6] is effected by means of their articulating processes, also (in the place of inter-vertebral substance, which would be altogether incompatible with the requisite movements) by the odontoid process of the former, which is connected in a particular manner with the arch of the latter, and constitutes the pivot on which the head turns in its rotatory motions. There are three ligaments and four synovial membranes in this articulation.

The *transverse ligament* (ligamentum atlantis transversum, Weit. Sœmm.) is a strong, thick fasciculus of fibres, compressed from before backwards, arched in its direction, and attached on each side to the inner border of the superior articulating processes of the atlas. It is broader and thicker at the middle than at its extremities. From the middle of its posterior surface a short thin bundle of fibres passes down to be attached to the root of the odontoid process, whilst another passes up to the basilar process. These appendages form a cross with the transverse ligament, and serve to bind the occiput to the two first vertebræ; from this is derived the term *cruciform*, which is sometimes applied to the transverse ligament. To bring these structures into view, the posterior part of the vertebral arches must be removed.

The *anterior Atlo-axoid ligament* passes from the border of the anterior arch of the atlas, and its tubercle, to the body of the axis and the root of its odontoid process. It is thin and membranous.

The *posterior Atlo-axoid ligament* connects the posterior arch of the atlas with the plates of the axis. Thus the interstices between the plates or arches, which in all the other vertebræ are filled by the ligamenta subflava, are occupied by a loose membrane between the second and first, as well as between the latter and the occiput. The edges of the articulating processes are connected by irregular fibres passing from one to the other.

Two synovial membranes are placed between the articulating processes of the atlas and axis. One between the odontoid process and the transverse ligament, another between it and the arch of the atlas.

Articulations of the Cranium.—The cranium is articulated, 1, with the atlas; 2, with the axis; 3, with the lower jaw.

The articulation of the cranium with the atlas [plate VIII. figs. 1—6] takes place between the

condyles of the occipital bone and the superior articulating processes of that vertebra, which are connected by ligaments and synovial membranes; it is also connected with the same by the two following ligaments.

The *anterior Occipito-atloidean ligament* (membrana annuli anterioris vertebræ primæ) extends from the anterior border of the occipital foramen, between the condyles, to the margin of the arch of the atlas between its superior articulating processes. This is thin, broad, and membranous; but in the median line a sort of accessory ligament is placed in front of it, which is thick, round, and composed of vertical fibres, attached above to the surface of the basilar process, and below to the small tubercle on the front of the atlas. The anterior surface of these ligaments is covered by the recti antici muscles, the posterior covers the odontoid process and its ligaments.

The *posterior Occipito-atloidean ligament*, also broad and membranous, is attached superiorly to all that part of the margin of the occipital foramen which is behind the condyles, and inferiorly to the adjacent border of the posterior arch of the atlas. It consists of two lamellæ, which are united at their superior attachment, but soon divide, one becoming blended with the dura mater, which lines the vertebral canal, whilst the other is inserted into the arch of the atlas. The posterior surface of the ligament is in apposition with the posterior recti and superior oblique muscles, the anterior looks towards the vertebral canal; at each side, near the articular processes, the ligament forms part of the foramina through which the sub-occipital nerves and vertebral arteries pass.

The articulation of the occipital bone with the axis is effected through the medium of ligaments, as no part of their surfaces comes into contact.

The *Odontoid ligaments* (ligamenta alaria) are two thick bundles of fibres attached below to each side of the summit of the odontoid process, and passing up diverging to be implanted into the rough depressions at the inner side of the condyles of the occiput, and also to a small part of the margin of the occipital foramen. Their direction, therefore, is obliquely upwards and outwards; the triangular interval which they thus leave is filled by some thin fibres passing almost perpendicularly from the margin of the foramen to the summit of the process. These are strictly check ligaments; the middle set, last described, prevent what may be termed a retroversion of the head, whilst the lateral pair check its rotatory motions.

The *Occipito-axoidean ligament* seems to be a prolongation of the posterior common ligament; it is attached above to the inner surface of the basilar groove, from which it descends perpendicularly, becoming narrow, and opposite the axis is blended with the posterior common ligament. It covers the odontoid process and its check ligaments, and is intimately connected with the transverse ligament.

Articulation of the Lower Jaw.—The lower jaw articulates [plate VIII. figs. 7—11] at each side by one of its condyles with the glenoid cavity in the temporal bone; hence it is called the temporo-maxillary articulation. By means of an inter-articular cartilage a double joint is formed at each side, with distinct synovial membranes.

The *external lateral ligament* is a short fasciculus of fibres, attached above to the external surface of the zygoma, and to the tubercle at the bifurcation of its root; below, to the external surface and posterior border of the neck of the condyle, its fibres being directed downwards and backwards. Externally it is covered by the parotid gland, internally it is in relation with the inter-articular cartilage and synovial membranes.

The *internal lateral ligament* thin, loose, and elongated, extends from the spinous process of the sphenoid bone downwards, and a little forwards, to be attached to the inferior maxillary bone at the lower border of the dental foramen, where it is somewhat expanded. Its external surface is in relation superiorly with the external pterygoid muscle, and in the rest of its extent with the ramus of the jaw, from which it is separated by the internal maxillary artery and dental nerve. Its inner surface is concealed by the internal pterygoid muscle.

The *Stylo-maxillary ligament*, thin and aponeurotic, passes from near the point of the styloid process to the inferior border of the angle of the jaw, where it is inserted between the masseter and internal pterygoid muscles.

The *inter-articular fibro-cartilage* is a thin plate, placed horizontally between the articular surfaces of the bones; it is of an oval form, and somewhat thicker at its margins than at its centre, where it is sometimes perforated. Its inferior surface, which is in contact with the condyle, is concave; the superior is alternately concave and convex when taken from before backwards,

conforming in some way with the outline of the articular cavity. Its circumference is connected at the outside with the external lateral ligament, and anteriorly with the external pterygoid muscle.

The synovial membrane, after lining the superior surface of the inter-articular cartilage, is reflected upwards on the external lateral ligament, and over the smooth part of the glenoid cavity; a similar membrane is interposed between the inferior surface of the cartilage and the condyle, so as to constitute a double joint.

Articulations of the Ribs.—The ligaments of the ribs [plate VII. figs. 1, 2, 7, 8, 9] may be divided into three sets: those which connect them—1, with the bodies of the vertebræ; 2, with their transverse processes; 3, with the sternum.

The *Costo-vertebral ligaments* (lig. capitulorum costarum) consist: 1. Of an anterior ligament which connects the head of each rib with the sides of the bodies of the vertebræ; its fibres, flat and radiated, are divided into three bundles, of which the middle one passes horizontally forwards upon the corresponding inter-vertebral cartilage, whilst the superior ascends to the body of the vertebra above it, and the inferior descends to that below. From the divergence of its fibres, this is usually called the *Stellate ligament.* 2ndly. Of an *inter-articular ligament*, which is a thin and short band of fibres which passes transversely from the ridge separating the two articular surfaces on the head of the rib to the inter-vertebral substance, and dividing the articulation into two parts, each lined by a separate synovial membrane. This ligament does not exist in the articulation of the first, eleventh, or twelfth ribs, and in consequence there is in them but one synovial capsule.

The *Costo-transverse ligaments* connect the tubercles of the ribs with the transverse processes of the vertebræ; from their position they are named posterior, middle, and anterior. 1. The *posterior costo-transverse ligament*, (lig. transversum externum costarum, Weit.) consists of a very short thick fasciculus of fibres which passes from the posterior surface of the summit of the transverse process to the rough unarticulated part of the tubercle of the rib. Those of the superior ribs ascend, those of the inferior descend somewhat. 2. The *middle costo-transverse ligament* consists of a series of very short parallel fibres, which unite the neck of the rib to the anterior surface of the contiguous transverse process. These fibres are seen by removing horizontally a portion of the rib and transverse process, and forcibly drawing one from the other. 3. The *anterior costo-transverse ligament* (lig. transversum internum costarum, Weit.) is usually divided into two fasciculi of fibres, both nearly in apposition, and on the same plane. They pass from the neck of the rib obliquely upwards and outwards to the lower margin of the transverse process next above it. These do not exist in the articulations of the first and last ribs. The articulations between the tubercles of the ribs and the transverse processes are provided with synovial capsules.

The *Costo-sternal articulations*, [plate VII. figs. 10, 11,] situated between the anterior extremities of the cartilages of the ribs and the fossæ, in the margins of the sternum, are covered and supported by, 1, an anterior set of ligamentous fibres, thin, scattered, and radiated, passing from the extremity of the cartilage to the anterior surface of the sternum, where they interlace with those of the opposite side, and are blended with the aponeurosis of the pectoralis major muscle; 2, a posterior set of fibres similarly disposed, but not so thick or numerous, connecting the thoracic surfaces of the same parts; 3, a synovial membrane, interposed between the ends of each true rib and the sternum, and also between the margins of each pair of false ribs, where they articulate with one another. These can be readily demonstrated by slicing off a little of the anterior surface of the sternum and cartilages. A thin fasciculus of fibres connects the cartilage of the seventh rib with the xiphoid cartilage, and is thence called the *Costo-xiphoid ligament.* The pieces of the sternum are connected by a layer of fibro-cartilage placed between their contiguous borders; and, on the anterior and posterior surfaces, some scattered ligamentous fibres may be observed running longitudinally, which serve to strengthen their connexion. These are sometimes called the anterior and posterior sternal ligaments.

Articulations of the Superior Extremities.—These may be arranged under the following heads, taking them in their anatomical order, from above downwards: 1, the articulation between the sternum and clavicle; 2, that of the scapula and humerus; 3, of the elbow; 4, of the wrist; 5, of the hand; 6, of the fingers.

The superior extremity has but one point of bony attachment to the trunk, namely, that at the sterno-clavicular articulation, the scapula being connected with the trunk by muscles only. The clavicle articulates with the first bone of the sternum, and is connected with its fellow of the opposite side, and the first rib, by ligaments.

The *Sterno-clavicular articulation* [plate XVI. figs. 5, 6] consists of an anterior and posterior ligament, an inter-articular cartilage, and two synovial membranes.

The *anterior Sterno-clavicular ligament* passes from the inner extremity of the clavicle, downwards and inwards, upon the surface of the sternum. It is broad, and consists of parallel fibres, and corresponds, internally, with the synovial membranes of the articulation, and with the inter-articular cartilage to which it is adherent; externally, with the sternal origin of the sterno-mastoid muscle.

The *posterior Sterno-clavicular ligament*, of similar conformation with the last, but not so broad or strongly marked, is placed between the same bones lying at the thoracic aspect of the joint. Its posterior surface is in relation with the sterno-hyoideus and sterno-thyroideus muscles.

The *inter-articular fibro-cartilage*, nearly circular in its form, and thicker at its border than at the centre, is interposed between the articulating surfaces of the sternum and clavicle. Towards its superior and posterior part it is attached to the margin of the clavicle, and at the opposite point to the cartilage of the first rib. In the latter situation it is thin and somewhat prolonged, so that the inferior border of the clavicle rests upon it.

Synovial membranes.—In this articulation, as in that of the lower jaw, there are two synovial membranes, of which one is reflected over the sternal end of the clavicle and adjacent surface of the fibro-cartilage, the other is disposed similarly between the cartilage and the articulating surface of the sternum.

The *Inter-clavicular ligament* is a dense fasciculus of fibres, placed transversely between the contiguous extremities of the clavicles. Its fibres do not pass directly across from one to the other; they dip down, and are attached to the upper margin of the sternum, by which it is rendered concave from side to side.

The *Costo-clavicular ligament* (ligamentum rhomboides, Weit. Sœmm.) does not properly form part of the articulation; yet it contributes materially to retain the clavicle in its situation. It is attached inferiorly to the cartilage of the first rib near its sternal end, and passes obliquely backwards and upwards, to be fixed to a roughness at the under surface of the clavicle.

The *Scapulo-clavicular articulation* [plate XVI. figs. 7, 8] is effected between the acromion process of the scapula and the external end of the clavicle. These points are connected, 1st, by a *superior ligament*, which is a strong broad band of fibres, passing from the superior surface of the acromion to the adjacent extremity of the clavicle; 2ndly, by an *inferior ligament* similar to the preceding, and placed at the under surfaces of the same bones; 3rdly, by a synovial membrane lining the two articular surfaces of the bones. As there is an inter-articular cartilage, there are sometimes two narrow synovial sacs, disposed in the same way as those in the sterno-clavicular articulation.

The *Coraco-clavicular ligament*, which connects the clavicle with the coracoid process of the scapula, presents two parts, each marked by a particular name. There is, however, no division between them, nor other distinction than that they look different ways.

The *posterior* or *internal fasciculus*, (conoid ligament,) broad above, narrow below, is attached, inferiorly, to the root of the coracoid process; superiorly, to a rough space at the inferior surface of the clavicle, its fibres being directed backwards and upwards. The *anterior* or *external fasciculus* (trapezoid ligament) passes from the superior surface of the coracoid process upwards, to an oblique line extending outwards from the tuberosity into which the conoid ligament is inserted; with the latter it unites at an angle, one of its aspects being directed forwards and upwards, the other downwards and backwards.

There are two ligaments [plate XVI. figs. 7, 8] proper to the scapula: 1. The *Coracoid ligament* (ligamentum proprium posterius) is a thin flat band of fibres, attached by its extremities to the opposite margins of the notch at the root of the coracoid process, which it thus converts into a foramen for the transmission of the supra-scapular nerve, the artery most commonly passing external to it. 2. The *Coraco-acromion ligament* (ligamentum proprium anterius) is a broad, firm, triangular fasciculus, attached by its broader extremity to the coracoid process, and by the narrower to the acromion, between which it is stretched almost horizontally. Its inferior surface looks downwards upon the shoulder-joint, the superior is covered by the deltoid muscle.

The Shoulder-joint.—The globular head of the humerus and the glenoid cavity of the scapula are the osseous parts which compose this articulation (*scapulo-humeral*). As the head of the humerus is large and prominent, whilst the cavity is merely a superficial depression, it must be

evident that they are retained in their situation not by any mechanical contrivance, but by the capsular ligament, and the muscles which are attached to the two tuberosities of the humerus.

The *Capsular ligament* [plate XVI. figs. 7, 8, 10] is attached superiorly round the margin of the glenoid cavity, and inferiorly round the neck of the humerus. It is broader in the latter than in the former situation; and its laxity is such, that if the muscular connexions of the humerus be detached, this bone drops away from the glenoid cavity. The superior and inner part of this membrane is covered and strengthened by a bundle of fibres, passing outwards and forwards from the coracoid process to the great tuberosity of the humerus (*coraco-humeral ligament*). Besides this, it receives additions from the tendons of the supra and infra spinatus muscles, from the teres minor and sub-scapularis, which are intimately connected with it, as they proceed to be attached to the tuberosities of the humerus. Thus its superior part is thick and firm, the inferior comparatively thin and weak. Its internal surface is lined by the synovial membrane; the external, besides the muscles already mentioned, is covered by the deltoid; inferiorly, it is in relation with the long head of the triceps and the circumflex vessels. The insertion of its inferior border is interrupted to give passage to the long tendon of the biceps muscle.

The *Glenoid ligament* [fig. 9.] appears to be continuous with the tendon of the long head of the biceps muscle: this at its point of attachment to the superior margin of the glenoid cavity, separates into two sets of fibres, which, after encircling it, meet and unite inferiorly. These fibres, by elevating the border of the cavity, render it a little deeper.

The *synovial membrane* lines the glenoid cavity, and is reflected over its lower margin until it reaches the inner surface of the fibrous capsule, on which it is prolonged as far as the neck of the humerus, where it separates from the capsule, and is applied upon the articular surface of the head of that bone, giving it a smooth investment. Viewed in this way, it appears a simple shut sac; and such it would be but for the peculiar relation of the long tendon of the biceps muscle to the shoulder-joint. The tendon is in fact enclosed in a tubular sheath, formed by an offset or process of the synovial membrane, which is reflected upon it where it is about to pass through the fibrous capsule, and is thence continued up to the summit of the glenoid cavity, where it is continuous with that part of the membrane which invests it. By this provision the integrity of the articulation and of the membrane is preserved.

On the superior and external surface of the capsule a considerable bursa mucosa is situated, by means of which the contiguous surfaces of the coracoid and acromion processes, and of the coraco-acromion ligament, are rendered smooth and lubricated, to facilitate their movements on the subjacent capsule.

The *Coraco-humeral* or accessory ligament, above noticed, extends obliquely over the upper and outer part of the articulation; it is attached to the coracoid process, and thence descends, intimately connected with the capsule, to the greater tuberosity of the humerus.

The Elbow-joint.—The lower extremity of the humerus is connected with the ulna and radius at the elbow, so as to form a hinge-joint. The sigmoid cavity of the ulna articulates with the trochlea of the humerus, so as to admit of flexion and extension only, while the cup-shaped depression on the head of the radius can turn freely on the rounded tuberosity to which it is applied. The bones are connected by four ligaments and a synovial membrane. [Plate XXI. figs. 1—6.]

The *internal lateral ligament*, composed of diverging and radiated fibres, presents two parts, each with a different aspect, one looking obliquely forwards, the other backwards. The anterior part is attached above, where it is narrow and pointed, to the front of the internal condyle of the humerus; its fibres, as they descend, become broad and expanded, and are inserted into the coronoid process, along the inner margin of the sigmoid cavity. The posterior part, of the same form (triangular), passes from the under and back part of the same process of bone downwards to the inner border of the olecranon; the superior fibres of this portion extend transversely between the points just named, the rest become successively more and more oblique.

The *external lateral ligament*, shorter and much narrower than the internal, is attached superiorly to the external condyle of the humerus, and inferiorly becomes blended with the annular ligament of the radius; none of its fibres are prolonged to the surface of that bone, for if they were they would check its rotatory motion. It is intimately connected with the tendinous attachment of the extensor muscles, on which account, when dissected, it presents a jagged, irregular appearance.

The *anterior ligament* is a broad thin membrane, placed in front of the joint, extending from the rough margin of the fossa, which receives the coronoid process during flexion, downwards to the an-

terior border of the coronoid process, and to the annular ligament of the radius. Some of its fibres are directed obliquely downwards and outwards, others are vertical.

The *posterior ligament,* loose and weak, consists of fibres proceeding in opposite directions; thus some pass transversely between the adjacent margins of the fossa which receives the head of the olecranon; whilst others, subjacent to these, but not very well marked, pass vertically from the superior concave margin of that fossa to the extremity of the olecranon.

Though these structures are described and named as separate ligaments, it will be found, on examination, that they form a continuous membrane placed round the joint, as fibrous capsules usually are, except only that the irregularity of the surfaces to which they are attached prevents their continuity from being readily perceived, and gives them the appearance of distinct ligamentous connexions passing from one point of bone to another.

The upper Radio-ulnar articulation.—The head of the radius articulates with the small sigmoid cavity of the ulna, on which it rolls when it is made to turn on its axis. These surfaces are covered with cartilage, and invested by the synovial membrane of the elbow-joint. The radius is connected to the ulna by an annular ligament.

The *annular* or *orbicular ligament* [plate XXI. figs. 2, 3, 4] is a strong band of circular fibres, which, by being attached to the borders of the small sigmoid cavity, forms a ring, encircling the head of the radius, and binding it firmly in its situation. Its external surface is in apposition with the external lateral ligament of the elbow, whose fibres are inserted into it; the internal is smooth and lined by the synovial membrane.

The *synovial membrane* of the elbow-joint, after having covered the articular extremity of the humerus, is prolonged a little on the anterior surface of that bone, as far as the attachment of the anterior ligament, where it is reflected, and applied to the internal surface of that membrane, lining it as far as its radio-cubital insertion; at that point the synovial membrane leaves the fibrous one, and invests the articularsur faces of the radius and ulna, and is extended over them until it comes into apposition with the posterior ligament, by which it is guided to the extremity of the humerus; in the same way, it lines the lateral ligaments. Besides these reflections, the membrane forms two pouches, one by being prolonged into the small sigmoid cavity, the other where it passes between the annular ligament and the contiguous surface of the head of the radius.

When the joint is laid open, and the bones extended, it will be observed that the head of the radius is not in contact with the rounded articulating process of the humerus. On which account, in the extended state of the limb, the rotatory motions of this bone are performed with much less ease than in that of flexion, from its wanting support at its upper end. The part of the humerus here referred to is moreover covered with cartilage only on its anterior aspect, indicating that the radius moves on it only when in the flexed position.

The middle Radio-ulnar articulation.—The interval between the radius and ulna in the fore-arm is filled up by an interosseous ligament and a round ligament, which serve to connect them together, and form what is called the middle radio-ulnar articulation.

The *interosseous ligament* [plate XXI. figs. 1, 2] (membrana interossea) is a thin, flat, fibrous membrane, the direction of its fibres being obliquely downwards and inwards, from the inner sharp border of the radius to the contiguous one of the ulna. It does not reach the whole length of the bones, as it commences about an inch below the tubercle of the radius. The surfaces of this membrane are intimately connected with the deep-seated muscles of the fore-arm, serving to increase their points of origin as well as to connect the bones. Inferiorly, it leaves an opening for the transmission of the anterior interosseous vessels; superiorly, there is another, but much larger interval, through which the posterior interosseous vessels pass.

The *round* or *oblique ligament* [figs. 1, 6] in some measure supplies the deficiency left by the interosseous ligament at the superior part of the arm. It is a thin narrow fasciculus of fibres, extending obliquely from the coronoid process, downwards and outwards, to be attached to the radius, about half an inch below its tubercle. The direction of its fibres is therefore altogether different from that of the fibres of the interosseous ligament.

The lower Radio-ulnar articulation.—At the lower or carpal ends of the radius and ulna, [plate XXI. figs. 1, 2; plate XXII. 1, 2, 4,] the former rotates on the latter as its point of support, the articulating surface of the radius being concave, that of the ulna convex. The bones are connected anteriorly and posteriorly by some fibres passing between their extremities, so thin and scattered as scarcely to admit or require description, but internally they are joined by a fibro-cartilage and a synovial membrane.

The *fibro-cartilage*, placed transversely between the bones, is attached by its base to a rough line separating the carpal from the ulnar articulating surface of the radius, and by its summit to a depression at the root of the styloid process of the ulna. Its superior surface looks towards the head of the ulna, the inferior to the cuneiform bone; both are smooth, and lined by synovial membrane; the inferior one by the large membrane of the wrist-joint, the superior by a small one peculiar to the radio-ulnar articulation. Its two borders are connected with the carpal ligaments. As the radius rolls on the ulna, this cartilage is carried with it, and forms its chief bond of union with the latter bone.

The *synovial membrane* is frequently called *membrana sacciformis*, though there is nothing in its conformation which distinguishes it from other synovial sacs. It may be considered as presenting two parts, one projecting perpendicularly upwards into the articulation of the radius and ulna, lining the contiguous surfaces of each; the other placed horizontally between the head of the ulna and the corresponding surface of the fibro-cartilage, lining them also; both, however, are formed by a continuous membrane.

The Wrist-joint.—This articulation (*radio-carpal*) [plate XXI. figs. 7, 8; plate XXII. figs. 1, 2, 4] is formed above by the radius and triangular fibro-cartilage, and the first three bones of the carpus below. The articular aspect of the former, when viewed in the fresh state, presents an oval and slightly concave surface, its greatest breadth being from side to side. The surface of the radius is divided into two parts, by a line extending from before backwards; so that these, together with the cartilage, present three articular surfaces, one for each carpal bone. The scaphoid, semilunar, and cuneiform bones are articulated together, so as to form a rounded convex surface, which is received into the concavity above described. Four ligaments and a synovial membrane retain these parts in their situation, as follow:—

The *internal lateral ligament* passes directly downwards, from the extremity of the styloid process of the ulna, to be attached to the cuneiform bone; it also sends some fibres to the anterior annular ligament and the pisiform bone. Its form is that of a rounded cord; its inner surface is in contact with the synovial membrane of the radio-carpal articulation.

The *external lateral ligament* extends from the styloid process of the radius to a rough surface on the outer side of the scaphoid bone, some of its fibres being prolonged to the trapezium, and also to the annular ligament of the wrist.

The *anterior ligament* (*radio-carpal*), broad and membranous, is attached to the rough border of the carpal extremity of the radius, and to the base of its styloid process, from which its fibres pass down to be inserted into the anterior surface of the scaphoid, semilunar, and cuneiform bones. It is pierced by several foramina for the transmission of vessels: one of its surfaces is lined by the synovial membrane of the joint, the other is in contact with the tendons of the flexor muscles.

The *posterior ligament* extends obliquely downwards and inwards, from the extremity of the radius to the posterior surface of the semilunar and cuneiform bones; its fibres appear to be prolonged for some way on the carpal bones. One surface is in contact with the synovial membrane, the other with the extensor tendons.

The *synovial membrane*, after having lined the articular surface of the radius, and the triangular fibro-cartilage, is reflected on the anterior and posterior ligaments, and thence over the surface of the carpal bones.

Articulations of the carpal bones.—The bones of the carpus consist of two sets, each united by its proper connexions, so as to form a row; and the two rows are connected by fibrous bands and a synovial membrane, so as to form between them a joint. [Plate XXII. figs. 1, 2, 3.] The connexions proper to the first row are interosseous fibro-cartilages, and ligaments placed on their dorsal and palmar surfaces.

The *inter-osseous fibro-cartilages* are two lamellæ, one placed at each side of the semilunar bone, connecting it with the scaphoid and cuneiform bones. The carpal extremity of these is smooth, and lined by the synovial membrane of the wrist-joint.

The *palmar ligaments* are two, one extending from the scaphoid bone to the semilunar, the other from the semilunar to the cuneiform, their direction being transverse, and as their fibres are partly united, they may be considered as a continuous band connecting these bones.

The *dorsal ligaments* are also two, disposed similarly and connecting the same bones on their posterior surfaces. The pisiform bone stands out of the range, and rests on the palmar surface of the cuneiform, with which it is articulated by an irregular fibrous capsule and a synovial membrane.

The carpal bones of the second range are also connected by similar means. Three *dorsal* and

palmar ligaments pass transversely from one bone to the other. There are, however, but two *inter-osseous fibro-cartilages*, placed one at each side of the os magnum, connecting it with the trapezoid externally, and the unciform internally. Such are the means of connexion peculiar to each row.

The ligaments which connect the upper to the lower row of bones are placed at their palmar, dorsal, and lateral aspects.

The *lateral ligaments* are placed one at the radial, the other at the ulnar border of the carpus; the former connects the scaphoid bone with the trapezium, the latter the cuneiform with the unciform.

The *palmar* or *anterior ligament* consists of short fibres, which pass obliquely from the bones of the first to those of the second range. The *posterior* is similar in structure and arrangement.

Synovial membrane.—It may be observed, that the first range of carpal bones forms a concavity; the second, particularly the os magnum and unciform, a convexity, which is received within it: by these means a ball-and-socket joint is formed, which is completed by a synovial membrane reflected over the articular surfaces of the different osseous pieces which compose it. The membrane, moreover, sends two processes between the three bones of the first row, and three between those of the second, so as to facilitate their respective motions.

Carpo-metacarpal articulations.—The last four metacarpal bones [plate XXII. figs. 1, 2, 3] are connected with those of the carpus by means of two sets of fibrous bands, situated, one on the palmar, the other on the dorsal surface, the latter being better marked. All but the fifth metacarpal bone receive two bands. Thus, to the second, or that of the fore-finger, a thin fasciculus of fibres passes from the trapezium, another from the trapezoid bone; the third receives one from the latter, and also from the os magnum; the fourth from the os magnum and also from the unciform; but the fifth is connected to the latter only. On the palmar surface a similar mode of connexion exists, but the fibres are not so well defined.

The *carpal extremities* of the last four metacarpal bones are bound together by three transverse fibrous bands on the palmar, and the same on the dorsal surface, passing from one to the other; they are slight, and often ill-defined.

The *digital extremities* of these metacarpal bones are connected at their palmar aspect by a flat band passing across them, and closely connected with the head of each; this is called the *transverse ligament.*

The *metacarpal bone of the thumb* is articulated on quite a different principle from the others; for, as it admits of all the motions except rotation, it is connected to the trapezium by a capsular ligament, which passes from the rough border bounding its articular surface to the trapezium: these parts are lined by a synovial membrane.

Articulation of the Phalanges with the Metacarpal bones.—The rounded head of each of the last four metacarpal bones being received into the slight concavity situated in the extremity of the first phalanx, is maintained *in situ* by two lateral ligaments, an anterior ligament, and a synovial membrane. [Plate XXII.]

The *lateral ligaments* consist of dense fasciculi of fibres, attached by one extremity to the sides of the metacarpal bones, by the other to the contiguous extremity of the phalanges, the direction of the fibres being forwards and downwards. The *anterior* ligaments occupy the interval between these on the palmar aspect of the joints; they are thin and membranous. The synovial membrane invests the surfaces of the heads of the bones, and is reflected on the ligaments which connect them.

The phalanges are articulated with one another, on the same principle as that which obtains in the articulation between their bases and the metacarpal bones; it is therefore unnecessary to repeat what has been just stated on that subject.

There are some other fibrous and ligamentous structures which deserve to be noticed in this place, but not as being connected immediately with the joints; they are rather accessories to the tendons of the muscles. Thus along the margins of the phalanges, on their palmar aspect, are attached the *vaginal ligaments*, which form sheaths for the flexor tendons, and bind them securely in their situation; these are thick and firm along the body of the phalanges, but over the flexures of the joints they are thin, so as not to impede their movements; their inner surface is lined by a fine membrane resembling the synovial class, which is reflected over the tendons, giving to each a smooth and shining appearance.

The *posterior annular ligament* of the wrist is continuous with the fascia of the fore-arm, of which it may be considered a part. It extends from the extremity of the radius, at its outer

border, to the inner border of the ulna and the pisiform bone, and serves to bind down the extensor tendons.

The *anterior annular ligament* is a dense fasciculus of fibres, extended across the carpus from the pisiform and unciform bones to the trapezium and scaphoides, so as to form a canal which transmits the flexor tendons, retains them in their situation, and modifies their direction and power of action on the hand.

Articulations of the Pelvis.— The os sacrum, considered as the common point of support of the vertebral column above, the os coccygis below, and ossa innominata on each side, is connected with each of these in the following manner :—

Sacro-vertebral articulation. [Plate XXV. figs. 1, 2, 4.]—The base of the sacrum is articulated with the last lumbar vertebra by means similar to those which connect the different pairs of vertebræ throughout the column ; 1, by an inter-vertebral substance placed between their oval surfaces ; 2, by the continuation of the anterior and posterior common ligaments ; 3, a ligamentum subflavum connecting the arches of the last vertebra with the posterior border of the sacral canal ; 4, an inter-spinous ligament ; 5, two synovial membranes between the articulating processes ; and lastly, a sacro-vertebral ligament. All these, except the last, being similar to the connecting media throughout the column, require no farther description in this place.

The *Sacro-vertebral ligament* extends obliquely from the transverse process of the last lumbar vertebra downwards to the depressed lateral surface at the base of the sacrum ; its form is triangular, as its fibres diverge and expand towards the sacro-iliac symphysis.

The *Ilio-lumbar ligament* is extended horizontally between the summit of the transverse process of the last lumbar vertebra and the posterior extremity of the crista of the ilium, where its fibres expand somewhat, so as to give it a triangular form. This is the only bond of union between the true vertebræ and the os ilium.

The *Sacro-coccygean articulation* [plate XXV. figs. 1, 2] is effected by, 1, an *anterior ligament*, consisting of irregular fibres, placed in front of these bones, subjacent to the rectum ; 2, by a *posterior ligament* more strongly marked, composed of fibres which descend upon the bones of the coccyx, from the margin of the inferior orifice of the sacral canal, which it serves to close in and complete ; 3, by a thin *fibro-cartilage* interposed between the contiguous extremities of the sacrum and coccyx with a synovial membrane which continues in the female to an advanced period of life.

The several pieces of the coccyx are connected one to the other by a continuation of the anterior and posterior ligaments which unite the sacrum and coccyx, and by very thin interposed fibro-cartilages. In the adult male the union between the sacrum and coccyx, and that between the pieces of the latter, are usually ossific ; but in the female this change most commonly does not occur till a very advanced period of life, and the mobility increases during pregnancy.

The *Sacro-iliac articulation*, [plate XXV. figs. 1, 2] often named the sacro-iliac symphysis, or synchondrosis, is formed between the rough lateral surfaces of the sacrum and ilium closely applied to one another, and connected by an irregular lamella of a cartilaginous structure. In addition to these means of union, the pelvic bones are connected by the following ligaments :—

The *posterior Sacro-sciatic ligament*, [plate XXV. figs. 1—4,] (ligam. sacro-ischiadicum majus, Weit., Sœmm.) elongated, broad, and triangular, is placed at the inferior and posterior part of the pelvis, whose lower aperture it assists materially in closing. Its base or broader part is attached to the postero-inferior spine of the ilium and to the side of the sacrum and coccyx ; whilst its other extremity is fixed along the inner margin of the tuber ischii, where it expands somewhat, and sends upwards and forwards along the margin of the ramus of that bone a falciform process, which presents one surface looking towards the perinæal space, and the other resting on the internal obturator muscle and pudic artery. The posterior surface of this ligament gives origin to part of the gluteus maximus ; the anterior is covered partly by the small sacro-sciatic ligament.

The *anterior* or *small Sacro-sciatic ligament* [plate XXV. figs. 1—4] (lig. sacro-ischiadicum minus, internum, Weit., Sœmm.) is attached by its base to the side of the sacrum and coccyx, where its fibres are blended with those of the great ligament, and by its apex to the spinous process of the ischium ; its form is triangular, the direction of its fibres forwards and outwards. The spinous process of the ischium, its tuberosity, and these two ligaments, bound an oval interval, through which pass the obturator internus muscle, and the internal pudic vessels and nerve ; but above the border of the anterior ligament is a large oval opening, (bounded before and above by the margin of the ilium and ischium, and behind by the great ligament,) which transmits the pyramidalis muscle, the great sciatic nerve, the gluteal and ischiadic vessels and nerves.

The *posterior Sacro-iliac ligaments* [plate XXV. fig. 2] consist of three or four sets of short irregular fibres, extended between the posterior rough portion of the surface on the side of the sacrum and the corresponding part of the ilium. Some of the fibres pass horizontally between the bones, others obliquely: of the latter, one band, extending downwards from the posterior superior spine of the ilium to the tubercles on the third or fourth piece of the sacrum, is described separately, under the name of (from its direction) the *oblique*, or (from being situated superficially to the others) the *posterior sacro-iliac ligament*. They are all placed deeply in the groove formed by the ilium and sacrum, and covered by the origin of the lumbar muscles. The *anterior sacro-iliac ligament* consists of some thin irregular fibres, placed at the anterior aspect of the sacro-iliac symphysis, and attached to the pelvic surfaces of the sacrum and ilium.

The *Pubic articulation* (symphysis pubis) [plate XXV. figs. 1, 4, 5, 6] is formed by the junction of the ossa pubis in the median line anteriorly. This is effected by an elongated piece of fibro-cartilage, interposed between their surfaces, and connected to each. It consists of concentric lamellæ, is thicker anteriorly than posteriorly, and frequently projects beyond the level of the bones in the latter direction. A provision is made in this part for a slight degree of movement, which, however, is more perceptible in the female than in the male. Each pubic bone, properly speaking, has its own plate of fibro-cartilage. These plates are connected by fibres passing transversely from one to the other at the fore part as well as at the upper and lower border; but at the middle and back part they are smooth, and often lined by a slight synovial membrane. The union between the bones is strengthened, 1st, by an *anterior pubic ligament*, which consists of irregular fibres, passing obliquely across from one bone to the other, and decussating on the anterior surface of the fibro-cartilage; the fibres are intermixed with those of the aponeuroses of the external oblique muscles of the abdomen; 2ndly, the *sub-pubic ligament*, (ligamentum triangulare, arcuatum,) thick and triangular, which is placed beneath the symphysis, its sides being attached to the rami of the pubis, its base free and slightly concave, directed downwards and backwards to the perinæal space; 3rdly, by some indistinct fibres which are situated on the posterior surface of the articulation, and others placed on its upper border: these may be named from their position.

The *Obturator ligament* [plate XXV. figs. 1, 4, 5] (membrana obturans foraminis thyreœidis, Sœmm.) is properly a fibrous membrane, inserted into the border of the obturator foramen, which it closes in its entire extent, except at the upper and outer part of its circumference, where a small oval aperture is left for the exit of the obturator vessels. The obturator muscles are attached to its surfaces.

The Hip-joint.—This is a true ball-and-socket joint, in which the globular head of the femur is received into the acetabulum or cotyloid cavity. The articulating surfaces are covered by cartilage in the greater part of their extent. It is deficient, however, at the bottom of the cavity, and also a little beneath the central point of the head of the femur; the latter marking the insertion of the round ligament, the former a shallow fossa for the lodgement of the structure which has been called the synovial gland. The connecting means in this articulation are three ligaments, [plate XXV. figs. 1, 3, 7, 8,] viz. a capsular, cotyloid, and inter-articular ligament, together with a synovial membrane.

The *Capsular ligament*, dense and firm in its texture, represents a fibrous tube, whose direction is downwards and outwards; being attached by one extremity round the margin of the cotyloid cavity, by the other to the neck of the femur. Its superior circumference, in the greater part of its extent, is attached to the bone, within two or three lines of the cotyloid ligament; but opposite the notch, where the margin of the cavity is deficient, it is attached to the transverse ligament. Its inferior circumference is inserted in front into the oblique line leading from one trochanter to the other; but superiorly and behind, its fibres are implanted into the neck of the bone, within a quarter of an inch of the trochanteric fossa, and about the same distance from the posterior intertrochanteric line. The ligament is most dense and firm towards the superior and anterior part of the articulation; inferiorly, its fibres are comparatively thin. A firm fasciculus of fibres extends obliquely downwards in front of the joint intimately connected with the capsule, being calculated to strengthen it, hence it is called its "accessory" ligament; but as one extremity of it is attached to the anterior inferior spinous process of the ilium, and the other to the anterior trochanteric line, it may be called the *ilio-femoral* ligament.

The *Cotyloid ligament* is a fibro-cartilaginous ring, placed round the cavity, and serving the purpose of increasing its depth, and completing its border, where it is deficient. The broader part or base of this structure is attached to the bone, its thin edge is free, and both its surfaces are

covered by the synovial membrane, the external being in contact with the capsular ligament, the internal with the head of the femur. Its fibres are not continued all round; they rather pass obliquely from without inwards, over the margin of the cavity, one extremity being attached to the outer, the other to its inner surface. At the cotyloid notch these fibres are continued from side to side, crossing one another, so as to render the circumference complete. Some additional fibres are superadded in this part; from which circumstance, as well as its being stretched across from one margin of the notch to the other, it is usually named the *transverse ligament.* Subjacent to the transverse portion an interval is left for the admission of the articular vessels.

The *inter-articular ligament* is not unfrequently called the "round" ligament (ligamentum teres capitis femoris, Weit., Sœmm.) It is a thick dense fasciculus of fibres, implanted by one extremity, which is round, into the fossa in the head of the femur; by the other, where it is broad, flat, and bifid, into the margins of the cotyloid notch, where its fibres become blended with those of the transverse ligament.

The *synovial membrane* lines the contiguous surfaces of all the parts which enter into the composition of the articulation, giving them a smooth and shining appearance. From the margin of the articular surface of the femur, it may be traced along the neck of that bone as far as the insertion of the capsular ligament, the inner surface of which it lines as far as its superior attachment. There it turns inwards over the cotyloid ligament, and dips into the cavity, lining its entire extent, and finally guided as it were by the inter-articular ligament (which it invests by a funnel-shaped process), it reaches the head of the femur, and invests it as far as the border of its cartilage, whence we proceeded in tracing its reflections.

The Knee-joint. — This is a ginglymus, or hinge-joint, formed by the condyles of the femur above, the head of the tibia below, and the patella in front, the contiguous surfaces of each being tipped with cartilage, and invested by a common synovial membrane. The following ligaments [plate XXVII.] enter into the composition of the articulation: the ligamentum patellæ, the external and internal lateral, a posterior, a transverse, and two crucial ligaments; besides these, may be enumerated two semilunar fibro-cartilages, and some folds of the synovial membrane, which have received names, viz. the ligamenta alaria and mucosum; but the term ligament cannot with propriety be applied to any other than fibrous structures which connect parts together.

The *ligamentum Patellæ* is a flat strong band of tendinous fibres, which connects the patella with the anterior tuberosity of the tibia. Its superior extremity is attached to the apex of the patella, and to a depression on its posterior surface; its superficial fibres pass upwards on the anterior aspect of the bone, and become continuous with those of the tendon of the rectus femoris; the inferior extremity is a little expanded; towards the middle its borders are slightly tucked in. The anterior surface of this ligament is subcutaneous in its whole extent; the posterior rests on the synovial membrane of the knee-joint, from which it is separated by some adipose substance, as it is inferiorly from the head of the tibia by a synovial bursa.

The *internal lateral ligament*, broad and flat, connects the tuberosity of the internal condyle of the femur with the inner surface of the head of the tibia. It becomes broad inferiorly, where it is covered by the tendons of the sartorius, gracilis, and semi-tendinosus muscles; internally it rests on the synovial membrane, and is attached to the internal semilunar cartilage.

The *external lateral ligament* is a rounded cord-like fasciculus of fibres, which passes from the tuberosity of the external condyle of the femur, to the head of the fibula; its direction is almost vertical; it is placed nearer the posterior than the anterior surface of the joint; its internal surface corresponds with the synovial membrane and the external articular arteries, the external being covered by the tendon of the biceps flexor cruris, and the expanded fascia of the extensor muscles. Posterior to this, but parallel with it, another ligament is placed, connecting the same points of the femur and fibula; it is called the *short external lateral ligament.*

The *posterior ligament* (ligamentum posticum Winslowi), broad and expanded, is a flat plane of fibres, stretched obliquely behind the articulation, from the internal tuberosity of the tibia to the external condyle of the femur. The direction of the greater part of its fibres is from below upwards and outwards, running diagonally across the joint, being evidently continuous with the tendon of the semi-membranosus muscle, of which they may be regarded as a prolongation. This ligament, however, cannot be considered as formed solely by a reflection of the tendon of the semi-membranosus, or merely as the third insertion of that muscle; for several transverse and perpendicular fibres are observed in it, distinct from those of the reflected tendon. Some apertures may be observed between its fibres, which transmit the posterior articular vessels.

The *crucial* or *oblique ligaments* (ligamenta cruciata) are placed at the posterior part of the joint, external to the synovial membrane, but partially invested by it. As the name imports, their direction is oblique, so that they cross or decussate somewhat like the lines of the letter X; the posterior one, however, approaches more nearly a perpendicular direction: of these one is anterior, the other posterior. The *anterior ligament* is fixed by its lower extremity to a pit, situated before the spine of the tibia, where it is connected with the anterior cornu of the internal semilunar cartilage; its upper extremity is inserted into the inner side of the external condyle of the femur; hence its direction is upwards, backwards, and outwards. The *posterior ligament* is attached inferiorly to the pit behind the spine of the tibia (where it is intimately connected with the posterior cornu of the external semilunar cartilage), and superiorly, to the side of the inner condyle; its fibres being directed upwards and a little forwards. Its interior surface is in contact with the last-mentioned ligament, and the posterior with the ligamentum posticum. Both are thus implanted into the fossa between the condyles.

The *semilunar cartilages* are two crescent-shaped lamellæ of the fibro-cartilage, placed on the articulating surfaces of the head of the tibia, interposed between them and the condyles of the femur. The outer border of each is thick and convex, the inner thin and concave, leaving the central part of the superior surface of the tibia uncovered.

The *internal semilunar cartilage*, elongated from before backwards, is nearly of a semicircular form; its anterior cornu is connected with the anterior crucial ligament, and is inserted into the pit before the spine of the tibia; the posterior is attached behind the spine, and is in relation with the posterior crucial ligament; its thick border is connected with the internal lateral ligament, the thin one is free and unattached.

The *external semilunar cartilage* forms nearly a complete circle; its two cornua, fixed one before the other behind the spine of the tibia, are so close at their insertion, that they may be said to be interposed between the insertions of the internal semilunar cartilage. Its external border is connected behind with the tendon of the popliteus muscle, and in the middle with the external lateral ligament. Towards the front of the joint the convex borders of the inter-articular cartilages are connected by a slight transverse band (*transverse ligament*). The superior surface of the fibro-cartilages is concave, and in apposition with the condyles of the femur; the inferior plane rests on the head of the tibia; both surfaces are invested in nearly their entire extent by the synovial membrane.

The *synovial membrane*, like all similar structures, forms a shut sac, whose surface is continuous throughout its entire extent, and as it lines the contiguous surfaces of all the parts entering into the composition of the knee-joint, it must necessarily present rather a complex arrangement. This complexity is increased by the existence of a small funnel-shaped fold (improperly named *ligamentum mucosum*), which is stretched across the joint from the lower border of the patella to the margin of the fossa, between the condyles of the femur. In order to exhibit the arrangement of the membrane, the joint should be laid open by a vertical incision carried along the inner margin of the patella and its ligament, leaving the ligamentum mucosum untouched. A lateral view of the joint being thus obtained, all the parts remaining in their natural position, it will be observed that the synovial sac is intersected and in a manner divided into two parts by a transverse funnel-shaped process (*ligamentum mucosum*); the superior one, elongated and pyramidal, projects by its summit more than an inch above the patella, its base corresponding with the breadth of the process just named. The inferior division of the membrane is quadrilateral, one side being made up of the lower border of the same process, and the smooth surface of the femur with which it is continuous; another by the articulating surface of the tibia; posteriorly it corresponds with the posterior crucial ligament, and anteriorly with the part of the membrane reflected on the ligamentum patellæ.

If we commence at the superior border of the patella to trace the reflections of the membrane, we find that it descends, lining its articulating surface; below its inferior border it corresponds with the ligamentum patellæ, from which it is separated by a considerable quantity of adipose matter; on reaching the margin of the tibia, it is reflected over its articulating surfaces, and also on both aspects of the semilunar cartilages, giving them a smooth investment; round the crucial ligaments also it forms partial investments, enclosing them as far as their attachments to the femur. The membrane will thus be found to be guided to the articulating surface of that bone at several points, viz. by the two crucial ligaments, by the funnel-shaped process, and by the external margin of the semilunar cartilages; from these points it expands over the condyles, and after ascending

for some way in front of the femur (forming a cul-de-sac between it and the tendon of the extensor muscles), it passes downwards to the margin of the patella, from which we proceeded to trace its reflections. At the sides of the patella the membrane forms two slight folds which are named "*alar*" ligaments (ligamenta alaria).

In the enumeration of the ligaments of the knee-joint, no mention has been here made of a fibrous capsule, as an investment distinct from the other fibrous structures of the joint. It is not usually described in anatomical demonstrations, and no notice of it occurs in the works of Meckel, Portal, Cloquet, or B. Cooper. A capsular ligament is, however, attributed to this articulation by Sœmmering, Weitbrecht, and Fyfe. The capsular ligament or membrane (membrana capsularis articuli genu) is said to arise in front from the whole circumference of the articulating extremity of the femur, at some distance from its cartilaginous coating, and behind from the border of the intercondyloid fossa, from which it descends, to be inserted into the rough border which surrounds the head of the tibia. The membrane is also inserted into the margins of the patella and its superior and inferior ligamentous connexions, so that this bone forms part of the capsule of the joint. "It is very thin, but is strengthened by the fascia of the limb, and the surrounding aponeurotic structures."

These are pretty nearly the words employed by Fyfe; the last clause approaches somewhat to a correct expression of the fact. The fascia lata is prolonged from the lower part of the thigh to the head of the tibia, and extends backwards upon the condyles, and forwards to the margins of the patella and its ligament; thus forming an exterior investment for the joint and its synovial membrane. The ligamentum posticum supplies its place at the back of the articulation.

Peroneo-tibial articulation.—The superior and inferior extremities of the tibia and fibula are connected by ligaments and synovial membranes, [plates XXVI. XXVII.] and the shafts of these bones are moreover maintained in relation by an interosseous ligament.

The contiguous extremities of the bones present superiorly two flat oval surfaces covered with cartilage, which are closely applied to one another, and retained *in situ*, 1, by an *anterior ligament*, which is a broad flat band of fibres, passing obliquely upwards and inwards, from the head of the fibula to the internal tuberosity of the tibia; it is covered and strengthened by the tendon of the biceps flexor cruris; 2, by a *posterior ligament*, similarly disposed behind the articulation, but stronger and thicker; 3, by a *synovial membrane*, which lines the articulating surfaces of the bones and ligaments.

The *interosseous ligament*, [plate XXVI. fig. 6,] which connects the bodies of the tibia and fibula, flat and membranous, is composed of a series of parallel fibres, extending obliquely between the external ridge of the tibia, and the ridge on the adjacent surface of the fibula. Most of the fibres run outwards and downwards, others cross them, and the membrane they compose is broader above than below, and presents in the former situation an elongated opening for the transmission of the anterior tibial vessels, and inferiorly a smaller aperture for the passage of the anterior branch of the fibular artery.

The inferior extremities of the tibia and fibula present two articulating surfaces, of which that of the former is concave, and receives the latter, which is convex, both being for a little way covered with cartilage; these are connected by four ligaments and a synovial membrane.

1. The *anterior ligament* (tibio-fibular) is a flat band of fibres, extended obliquely between the heads of the bones, the direction of its fibres being downwards from the tibia to the fibula.

2. The *posterior ligament*, somewhat triangular, is similarly disposed behind the articulation; its external surface is covered by the peronei muscles.

3. The *transverse ligament*, longer but narrower than the former, with which its fibres are closely connected, extends from the head of the fibula to that of the tibia; it forms the posterior boundary of the ankle-joint.

4. The *inferior interosseous ligament* consists of some short dense fibres, which connect the heads of the bones, as the great interosseous ligament does their bodies; it cannot be seen until the anterior and posterior ligaments are removed, and the bones in some degree separated.

The Ankle-joint.—This articulation [plate XXIX. figs. 9—13] consists of the inferior extremities of the tibia and fibula, united so as to form an arch, into which the superior convex surface of the astragalus is received. Their contiguous surfaces are covered with cartilage, lined by a synovial membrane, and retained in contact by the following ligaments. The *internal lateral ligament* (ligamentum deltoides) is a broad flat fasciculus of fibres, one extremity of which is attached to the inferior border of the internal malleolus, the other to the inner side of the astragalus and os calcis.

It is broader below than above; its cutaneous surface is covered by the tendon of the tibialis posticus muscle; the articular one is lined by the synovial membrane.

The *external lateral ligament* consists of three distinct fasciculi of fibres, separated by intervals and disposed in different directions. 1. The central one (*ligamentum fibulæ medium*) descends perpendicularly from the extremity of the fibula, and is inserted into the middle of the external surface of the os calcis. 2. The anterior fasciculus (*ligamentum fibulæ anterius*), passes obliquely forwards from the inferior extremity of the fibula, to the anterior border of the articular surface of the astragalus; it is the shortest of the three. 3. The posterior (*ligamentum fibulæ posterius*), the strongest of the three ligaments, passes obliquely backwards from the extremity of the fibula, towards the posterior surface of the astragalus, where it is inserted into the border of the groove for the tendon of the flexor longus pollicis.

At the anterior aspect of the joint is a broad thin membranous band, composed of irregular fibres, extended obliquely from the border of the articulating surface of the tibia to the margin of the pulley-like surface of the astragalus. This is usually called the *Tibio-tarsal ligament;* it is covered by the tendons of the extensor muscles.

The *synovial membrane*, after having invested the articulating surface of the astragalus, is reflected upwards at each side upon the lateral ligaments, and at the anterior and posterior part of the joint, upon the corresponding fibrous structures, so as to reach the articulating surfaces of the tibia and fibula by several points at once. These it lines in their entire extent, and also sends upwards between the bones a process which reaches as far as the inferior interosseous ligament; so that the inferior articulation between these bones may be said to form part of the ankle-joint, as both are lined by the same synovial membrane.

Articulations of the Foot.—The foot is constructed on the principle of an arch, being concave inferiorly, where it rests on the ground, and convex superiorly, where it receives the weight of the body, transmitted to it by the bones of the leg. The posterior extremity, or heel, is narrow, thick, and rounded; the anterior, flat, thin, and expanded, being composed of the digital phalanges. The internal border, longer than the external, thick, and nearly straight, is composed of the inner border of the calcaneum, the scaphoid, first cuneiform, and first metatarsal and digital bones of the great toe: the external, shorter and thinner, consists of the calcaneum, the cuboid, the fifth metatarsal, and corresponding digital bones.

The foot being divided into the tarsus, metatarsus, and phalanges, its different parts are respectively bound together by ligaments, and all are united so as to form a whole.

The seven bones of which the tarsus consists may be divided into two sets, the os calcis and astragalus forming the first, the scaphoid, cuboid, and three cuneiform bones, the second.

Articulation of the Astragalus with the Calcaneum.—The astragalus is connected to the calcaneum by three ligaments [plate XXIX. fig 13, plate XXX.], the chief of which is situated between the bones, and unites them somewhat after the manner that bivalve shells are connected by their muscle. This is termed the *interosseous ligament;* its breadth from side to side is more than an inch; the fibres of which it is composed pass perpendicularly between the bones, one extremity being fixed to the groove between the articulating surfaces of the calcaneum, the other to a corresponding depression in the astragalus. The *posterior ligament* connects the posterior border of the astragalus with the upper surface of the calcaneum; its fibres are oblique, its length and breadth not more than three or four lines. The *external ligament* is a slight fasciculus which descends perpendicularly from the under surface of the astragalus to the external side of the calcaneum; its direction is parallel with the external lateral ligament of the ankle-joint. It may be farther observed, that as the astragalus is wedged in between the malleoli, and as the lateral ligaments pass downwards from these to the os calcis, they must contribute somewhat to retain the astragalus in its proper position with regard to the latter bone.

Articulation of the Calcaneum with the Scaphoid bone.—This is effected by means of two ligaments [plate XXX.], their surfaces not being in contact. Of these ligaments, the inferior or plantar one (*ligamentum calcaneo-scaphoideum inferius*, Meckel), much the largest, passes forwards and inwards from the extremity of the calcaneum to the inferior surface of the scaphoid bone; its fibres are flat and horizontal, and in contact inferiorly with the tendon of the tibialis posticus muscle; superiorly they form part of the fossa which receives the head of the astragalus. The *external* or *dorsal ligament* (lig. calcaneo-scaphoideum externum) forms the external boundary of the cavity just mentioned; its fibres, very short, are directed from behind forwards between the contiguous extremities of the bones.

Articulation of the Astragalus with the Scaphoid bone.—The astragalus forms with the scaphoid bone a ball-and-socket joint. [Plate XXX.] The anterior articulating surface of the calcaneum, and the inferior calcaneo-scaphoid ligament, also may be said to enter into this articulation, as all the parts here mentioned are lined by a common synovial membrane. On the dorsum of the foot the astragalus is retained in its situation by the *ligamentum astragalo-scaphoideum*, a broad band of fibres extending obliquely forwards from the anterior extremity of the astragalus to the superior surface of the scaphoid bone. It is covered by the extensor tendons. The necessity for an inferior ligament between these bones is removed by the existence of the calcaneo-scaphoid ligament. The *synovial membrane* lines the concave surface of the scaphoid bone, the calcaneo-scaphoid ligament, and the elongated articulating surface of the calcaneum; from these it is reflected to the under surface of the astragalus and its scaphoid ligament, and so to the bone of that name from which we began to trace it.

Articulation of the Calcaneum with the Cuboid bone.—The connexion between these bones is maintained by three ligaments [plate XXX.] and a synovial membrane. The *superior calcaneo-cuboid ligament* is a broad flat band of fibres, which connects the anterior and superior surface of the calcaneum with the adjacent part of the cuboid bone. The *inferior* ligament consists of two distinct fasciculi of fibres, differing in form and attachments, of which one is superficial, the other deep-seated. The superficial one, called the *long plantar ligament* (ligamentum longum plantæ), is the longest of the tarsal ligaments. Its fibres, attached posteriorly to the inferior surface of the calcaneum, pass horizontally forwards, and become intimately connected with the rough tuberosity on the under surface of the cuboid bone; the greater number of them are continued forwards, and terminate at the base of the third and fourth metatarsal bones. The *deep-seated calcaneo-cuboid ligament* lies close to the bones, being separated from the former by some cellular tissue; its breadth is considerable, its length scarcely an inch, one extremity being attached to the calcaneum before the long ligament, the other (somewhat expanded) to the under surface of the cuboid bone. A synovial membrane lines the contiguous surfaces of the two bones, and is necessarily reflected upon the articular aspects of the superior calcaneo-cuboid ligament and the deep-seated ligament just noticed.

Articulations between the second set or range of Tarsal bones.—The second range of the tarsal bones, viz. the scaphoid, cuboid, and three cuneiform, are connected together in the following manner, so as to form separate articulations between each pair of them. [Plate XXX.]

1. The *scaphoid* and *cuboid* bones, when in contact, which is not always the case, present two small articulating surfaces, at their edges covered with cartilage, and lined by a synovial membrane. They are connected by a *dorsal ligament*, composed of short thin fibres, extended obliquely between the two bones; and a *plantar*, situated in the sole of the foot, and composed of transverse fibres.

2. The *cuboid* and *the external cuneiform bones* are connected by a *dorsal* ligament, which is a thin fasciculus of fibres extended between them, and a *plantar ligament*, whose fibres are transverse.

3. The *scaphoid* and *the cuneiform bones* are held together by dorsal and plantar ligaments. It will be recollected that the scaphoid bone articulates with the three cuneiform by the smooth faces on its anterior surface. The *dorsal* ligaments, three in number, pass from the superior surface of the scaphoid to the first, second, and third cuneiform bones, into which they are inserted. The *plantar ligaments* are similarly disposed on the under surface of the bones, but not so strongly marked.

4. The three *cuneiform* bones are connected by two dorsal and two plantar ligaments extended transversely from side to side; the internal one is broader and stronger than the other. The contiguous flat surfaces of the bones are lined by synovial membranes.

Articulation of the Tarsus and Metatarsus.—The four anterior bones of the tarsus, viz. the three cuneiform and the cuboid, articulate with the metatarsus. [Plate XXX.] The first and third cuneiform bones project beyond the others; so that the anterior extremity of the tarsus is very irregular. The first metatarsal bone articulates with the internal cuneiform; the second is wedged in between the first and third cuneiform; the third metatarsal bone articulates with the extremity of the corresponding cuneiform, and the two last with the cuboid bone. The articular surfaces of the bones are lined by synovial membranes, and they are held in contact by *dorsal* and *plantar* ligaments. These are flat, thin bands of parallel fibres, which pass from behind forwards, connecting the contiguous extremities of the bones just mentioned. Thus the first metatarsal bone receives a broad thin band from the corresponding cuneiform bone; the second receives three, which con-

verge to its upper surface, one passing from each cuneiform bone; the third has one from the third bone of that name; and, finally, the two last are bound by a broad fasciculus to the cuboid bone. The plantar set is similarly disposed; the first and second are more strongly marked than the corresponding ligaments on the dorsal surface.

Articulations of the Metatarsal bones with one another.—The five elongated bones which form the metatarsus are connected by ligaments [plate XXX.], so as to form an integrant part of the foot. At their posterior or tarsal extremity, two sets of ligaments are situated, one on the dorsal, the other on the plantar surface. These consist of three short thin bands of fibres, which pass transversely across the contiguous extremities of the four last metatarsal bones; the plantar set is similarly disposed; but no such connexion exists between the first and second bones. At the anterior or digital extremity the five bones are connected by a *transverse* ligament, which is a flat thin band of fibres, passing across from the extremity of one bone to the other; it is situated on the plantar surface of the metatarsus.

Articulations of the Metatarsal bones with the Digital phalanges.—The anterior extremities of the metatarsal bones are connected [plate XXX.] with those of the phalanges by two lateral ligaments, an inferior ligament, and a synovial membrane, similar in every respect to those of the hand.

The articulations of the phalanges with one another are also constructed on the same principle as those of the superior extremity. In each, the bones are held in contact by two lateral ligaments, and an anterior ligament which is thin and membranous; the surfaces being lined by a synovial membrane.

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LONDON :
PRINTED BY SAMUEL BENTLEY,
BANGOR HOUSE, SHOE LANE.